# SINUOSITY CALCULATIONS ALONG THE MEANDERING RIVERS OF THE PANNONIAN BASIN – CONCLUSIONS IN NEOTECTONICS AND RIVER DYNAMICS

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Thesis book

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In this work, the meandering rivers of the Pannonian Basin were analyzed. Their natural channels were mapped during the 2nd Military Survey of the Habsburg Empire. Along the digitized river sections, the sinuosity were calculated with different window sizes and the result was used to get conclusions in neotectonics and river dynamics.

<u>Studies in River dynamics:</u>

The basis of this study was the work of Timár (2003). He combined two graphs to make a quasi-3D graph. The horizontal diagram displays the connection between the bankfull discharge, the channel slope and the river patterns (Leopold and Wolman, 1957; Ackers and Charlton, 1971; Miall, 1977). The vertical diagram displays the results of the flume experiments of Shumm and Khan (1972), who studied the connections between the slope and the sinuosity.

The graph of Timár (2003) suggests that this connection can works for every water discharge. The slope and discharge of the rivers I studied in the Pannonian Basin varies widely. Using these values, I tried to make a real 3D graph, to represent the behavior of the rivers in the Pannonian Basin. The used database contained the average water discharge of the rivers, so I converted them to bankfull discharge. Williams (1978) summarized several bankfull discharge converter formulas, but all of them need some geometric parameters (e. g. cross section area). There were no formulas to count the bankfull discharge using only the average discharge. Van den Berg (1995) collected the average and bankfull discharge of lots of American rivers and creeks. I plotted the meandering ones on a log-log scale, and fitted a line on them. Then I generated the bankfull discharges from the average discharges by using this fit equation.

The channel slope values also needed some modification. The database contained the slope values of the regulated channels. The river control works increased the slope by decreasing the channel length. Viczián (1905) gives not only the slope and discharge values, but the distance along the river between the measuring station and the issue. I compared these intervals with the distance of these villages along the digitized river sections (channel length before the regulation). The slope corrections were made for every river reach between the measuring stations.

I tried several interpolation methods to get the surface. However, the river patterns are affected by some additional parameters, mainly the sediments. Finally, a smoothed surface was plotted, using the local polynomial regression. At last, I made some checking: I collected the original points of the unorganised meandering/wandering section of the surface, and compared to the surveyed patterns. Along these sections, the shapes of the rivers were between the meandering and the braided patterns.

> **Flume experiments indicated a connection between the slope and sinuosity values at very low water-discharge. My results verify this connection in a wide range of bankfull discharge along the rivers of the Pannonian Basin, and prove that the sinuosity change is a useable parameter to detect the vertical movements of the surface.**

<u>Neotectonical analysis</u>

This abstract surface also verifies that the changing slope affects the river pattern. This statement was analyzed several times using flume experiments or natural river channels. The new parts of my method were the moving-window sinuosity calculation and the using of several (usually 10 different) window-sizes. The sinuosity values were displayed on a spectrum-like diagram, to make the changes of the sinuosities more visible. The detecting of the significant sinuosity changes was a subjective process: it was depended on the colour scale and the analytic person. The maximum sinuosity values were different along the studied rivers. So the thresholds of the low, medium and high sinuosity sections cannot be unified.

I tried to make the interpretation more specific using a classification method. The sinuosity values were imported like a multi-channel image. The different channels contained the sinuosity values calculated with different window-size. Using these channels, an isoclass unsupervised classification was made for each river. The points were discriminated into 5 classes, because this number is manageable and enough high to separate not only the extreme high changes. I expected some connection between the sinuosity values: higher sinuosities belong to higher classes. However, some other factors also affected the classification (e. g. the changes of the sinuosity values with different window-sizes).

I analyzed how the method works along known active faults. This was studied not only in the Pannonian Basin, but along the Po (Italy), Menderes (Turkey), and Mississippi and Missouri (USA) rivers. In the area of the Pannonian Basin, I used the tectonic lines of the neotectonic map (Horváth et al., 2006). In some cases I also analyzed some seismic sections, to detect the faults.

**In the Pannonian Basin 29 rivers were studied, and 21 of them cross fault lines, according to the neotectonic map. Along 28 fault lines, at 38 points, the places of the significant sinuosity changes and the faults on the neotectonic map correlate. During the classification 11 river crossed fault lines. Along 16 fault lines, at 23 points, the places of the class changes and the fault lines on the neotectonic map correlate. I give their geological interpretation in the case studies. Some places were found, where positioning of the faults on the neotectonic map could be improved according to the sinuosity jumps.**

The difference between the results of the two methods was caused by the limits of the classification method: the first and last 25 km sections of the rivers are missing. Some faults just crossed the rivers at these sections.

There are some more sinuosity changes, where no fault lines displayed on the neotectonic map. Nevertheless, not only fault lines could cause vertical movements, and not only vertical movements could change the sinuosity. Most of the small sinuosity changes correspond to the tributaries which modify the water and sediment discharge.

The compaction of the young sediments also could cause the sinking of the surface. So my results were compared to the Map of the vertical surface movements (Franyó, 1992; Joó, 1992) and the Thickness of Neogene-Quaternary basin fill (Horváth, 1985).

<u>Case studies</u>

At the end of my work, I made some case studies, to highlight the connection between the sinuosity changes and the neotectonic activity. Along the *<u>Körös River System</u>*, an anastomosing river section appears near Berekböszörmény. Here, the fault line changed the river pattern instead of the sinuosity. The rivers and also the fault lines in this area are enough close to each other to make a block-model, and demonstrate the moving directions of the blocks, according to the river sinuosity changes.

The *<u>River Latorca</u>* is an ideal example to display the effect of a fault: upstream the faul line, the river has low sinuosity values and the points belong to the Class1 or Class2; downstream the sinuosity is increasing, and the Class3, Class4 and Class5 appear. The *<u>River Szamos</u>* is the opposite of the River Latorca: the sinuosity changes are not always affected by tectonic lines. Near Jibou, an antecedent valley causes the high sinuosities. Downstream

Szamosveresmart the sediment thickness increased suddenly. The compaction of the sediment causes the sinking of the surface, so the slope and sinuosity increases. Along *River Kis-Szamos* the neotectonic map could be improved according to the changes of the river.

Leaving the Pannonian Basin, along the *River Po* *(Italy)* and *River Menderes* *(Turkey)*, antecedent valleys also appear, but not only these features caused the high sinuosity values. As soon as the *River Po* crosses the fault lines, the sinuosity always changes. The tributaries arriving from the highland also affect the sinuosity by increasing the water and sediment discharge. The same phenomena appear along the *River Menderes*.

I also made the sinuosity spectrum and the classification along the *River Mississippi and Missouri* *(USA)*. For case studies, I selected two short sections along the River Mississippi. One of them was between St. Louis and Cairo, to compare my methods with the results of Adams (1980). The other section was along the New Madrid Seismic Zone where lot of earthquakes prove the existence and activity of a fault system. The behaviour of the river also verifies the active tectonic: here appear the highest sinuosity values and the points belong to Class5.

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