THE PANNONIAN PLAIN: DENOMINATION, DEFINITION AND SUBDIVISION (GF 2019 THEMATIC ISSUE)

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Abstract: The Pannonian Plain is a landscape or physico-geographic unit. It encompass the plain lowland landscapes of the Pannonian realm. If we follow the Pannonian Plain along the Danube valley, it starts from with Vienna Basin downstream till the Iron Gate.

The Pannonian Plain can be subdivided in six landscape units. The three main units are: The Vienna Basin, The Little Alföld, Alföld. The three smaller units have some kind of connections with the Alföld they are the Inner Somogy, the western Drava Plain Alföld and the Upper Sava Plain.

The Pannonian Plain has no synonyms. the terms Pannonian Basin, Pannonain realm, Pannonian Basin System as well as the Carpathian Basin have different meanings.

Keywords: Pannonian Plain; geomorphologic subdivision; landscape; Pannonian Basin, Carpathian Basin.

Introduction

In the relief analysis we should clearly pointed what means under the term plain. One of the most appropriate definitions can be find in study of the North American physical geography published after WWII (Finch et al., 1957) the major classes of the terrain based upon similarities and differences with respect of main characteristics: "...relatively amount of gently sloping land, local relief, and generalized profile. Plains were defined as surfaces having a gently sloping land coupled with local relief. Within the broad limits allowed by this definition, however plains exhibit a surprising degree of variety. Some approach as near to perfect flatness as it is possible for a land surface to become, while others are so rolling or dissected as barely to avoid being classed as hills. Some are marshy or seasonally waterlogged, while others are arid sand, gravel or soil. Some are rock-floored; others are surfaced with permanent snow or ice. Some are lie near the sea level while others are thousands meters higher. The only statement that apply to all are that most most of their slopes are gentle and that the differences in elevation within limited areas are small (Finch et al., 1957 p. 265)."

Beside the previous definitions also some shorter definitions summarized in Ćalić et al. (2012a): "Although extensively used in toponymy and regional geosciences, the term "plain" is insufficiently defined in textbooks, dictionaries and

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encyclopedias. Among all geosciences, it is geomorphology which should give a clear definition of the term. The existing precise definitions mostly refer to particular sub-types within the term, such as: floodplain, coastal plain, alluvial plain, alluvial fan, etc. In his “Dictionary of Geography” Moore (1972) defines a plain as “an extensive area of level or gently undulating land, usually of low altitude”, and lists the above mentioned sub-types defined according to the ways of formation. Encyclopedic references usually give short consice definitions of general and qualitative character (“large area of level or nearly level land” in Columbia Electronic Encyclopedia; “relatively level area of the Earth's surface that exhibits gentle slopes and small local relief” in Britannica Concise Encyclopedia; etc.). In many references (e.g. Guzzetti et al., 1997; Panin et al., 1999) particular forms within plains are discussed, but the overall notion of the plain is taken for granted, without an exact definition. Bognar (1987) offered quite a broad definition of a plain (in the case study of the Pannonian Plain), suggesting that apart from the flat lowland and plateau morphographic types, the plain includes also the hilly and mountainous forms occurring within its borders.

One of the very rare quantitative approaches to the definition of major relief units, including plains, was given by Hammond (1954). Instead of usual geomorphological focusing on particular forms, he pointed that the small-scale representation should be based on “areas, not simply of individual features.” (Hammond, 1954; p.35). His aim was to distinguish regional patterns of crustal relief explicitely and objectively, using the following factors: relief (dissection; vertical difference; “flatness”), slope, pattern and surface material. The areas having >80% of flat land with less than 33 m dissection are classified as plains (Hammond, 1954).

Taking into account both genesis and morphometry, we could define a plain as a levelled area of topographic surface, the development of which is conditioned by geotectonic processes and paleogeographical evolution, and whose morphology is characterised by meter-scale topographic denivelations of exogeneous origin. Fluvial accumulation (aggradation) is the dominant sedimentary process in low-lying plains. Apart from fluvial forms (floodplains, oxbow lakes), eolian processes and forms are often present as well, shaping the detailed morphology of a plain.” (Ćalić, 2012a p. 242).

The objectives towards the definition of the Pannonian Plain has been opened eight years ago. Its delineation was more restricted on administrative limitations because it was done within national borders (e.g. Ćalić, 2012a, 2012b) (Fig. 1). The aim of this this study to define the whole spatial aspects to define the physico-geographical/landscape unit what we called under the name Pannonian Plain, as well as to make its subdivision also.

Figure 1. The Serbian segment of the Pannonian Plain (cropped from Ćalić et al. 2012a). (THIRD PAGE)

Material and Methods

The first task of this study was to find a basement for the land-surface analysis. The area which will analyzed in the geologic-teconic sense defined under the name Pannonian Basin System (*sensu* Royden 1983a, 1983b) (Fig. 2). The second main task was to disseminate the plain segments within the Pannonian Basin System.

Figure 2. Thickness of the Neogene deposits of the Pannonian Basin System. (source: Hámor et al, 2001 identical as in Nagymarosy & Hámor, 2012) (HALF PAGE)

The analyzed the area of the Pannonian Basin System and its vicinity. The total number of 186 DEM-s of 30 m resolution were used from the Earth Explorer DEM collection of the United States Geological Survey (https://earthexplorer.usgs.gov) which were merged in the one DEM using QGIS software. The pixel resolution used in our case was 100 x 100 m.

The study beside the geologic surveying data for the study, on the DEM the roughness tool from QGIS Software used for the delineation of the Sava Plain (Gaudenyi & Mihajlović, submitted A) and for the Alföld (Gaudenyi & Mihajlović, submitted B).

"Tools to analyze and visualize DEMs outputs the single-band raster with values computed from the elevation. Roughness is the degree of irregularity of the surface. It is calculated by the largest inter-cell difference of a central pixel and it surrounding cell. The determination of the roughness plays role in the analysis of terrain elevation data., it is useful for calculation of river morphology and physical geography in general, is derived from the GDAL DEM utility" (QGIS 2.8 User Guide). As it is mentioned the DEM resolution 100 x 100 m was chosen which enables the good generalization for visualization of spatial objects on this level. With the tool "Roughness" of QGIS software we separate the surface roughness in five classes. The plain terrain of the Sava valley was defined with roughness coefficients of 0-5 (similar as in Ćalić et al, 2012a, 2012b). Later the generalization and the manual delineation was drawn. The division of the Pannonian Plain was based on boundaries was based on landscape subdivision of the Pannonian-Carpathian region (e.g. Kocsis, 2018).

Results

Denomination and definition of the Pannonian Plain

Historic-cultural precedents of for the Pannonian Plain can be found in the Pannonian Province or Pannonia of the Roman Empire which existed in the Roman Empire from 1st to 4th century A.D, encompassing the areas from the Vienna Basin on the north to the Sava River on the south, while the eastern border approximately followed the course of the Danube. In case of the Pannonian Plain the word Pannonian is related to the area of the Pannonian Basin System (and Pannonian Basin), while plain as a surficial forms of the relief connected with the "almost flat" morphology which defined in the Introduction chapter.

Figure 3. The delineation of the Pannonian Plain based on roughness classification classes examined with QGIS software. (WHOLE PAGE)

Figure 4. The delineation of the Pannonian Plain based on roughness classification classes examined with QGIS software. (WHOLE PAGE)

The subdivision of the Pannonian Plain

The subdivision was based on the area defined with the roughness classification of the relief (Fig. 3 and Fig 4) and based on the taxonomy of the natural landscapes in the Carpathian-Pannonian region (see Fig 19. in Csorba et al, 2018). The major landscape units of the Pannonian plain are the Vienna Basin, the Little Alföld and the Alföld. The smaller units are linked with the Alföld, they are: The Inner Somogy Plain, the western Drava Plain (Drava Plain westwards from the Alföld) and the Upper Sava Plain (*sensu* Gaudenyi & Mihajlović, submitted A) (Fig. 3 and 4).

Discussion

Discussion on denomination of the Pannonian Plain

The first use of the Pannonian Plain (in Croatian: *Panonska nizina*) by the prominent Croatian geoscientist Gorjanović-Kramberger (1914). In his study the Pannonian Plain defined as the plain of administrative area Croatia and Slavonia (included Syrmia). The analogue of the Pannonian Plain Gorjanović-Kramberger (1914) was the historic Roman province Pannonia pointed the area westwards from the Danube. However after the constitution of the Kingdom of SHS and later Yugoslavia the prominent geoscientist and one of the most influential Serbian geographer Cvijć used the term Pannonian Basin (Cvijić, 1920, 1924, 1926). However, the introduction of the term Pannonian Basin into scientific literature took place when the Pannonian stage (now described as regional Pannonian *s.l.* stage) was defined in stratigraphical references by Róth von Telegd (Róth, 1879; Róth von Telegd, 1879).

"The Pannonian Basin is a palaeogeographical term connected to the spatial extent of the Lake Pannon and its sediments. Under the name Great Pannonian Basin (in German: *grossen pannonischen Becken*; in Hungarian: *nagy pannoniai medencze*), Róth von Telegd (Róth, 1879; Róth von Telegd, 1879) presented the sedimentation basin in which the following facies were deposited: Pontian (Congeria beds), Levantine (Paludina beds) and Trachian (Belvedere beds; restricted to the Vienna Basin). The reason for the birth of this term was to unite the above mentioned beds, which could not be clearly separated one from another. At that time, this term perfectly fitted because it encompassed the areas of both sides of the Leitha Mts., or simply to the east of the Danube course in the Carpathian Basin and the Vienna Basin – locations where the Pannonian sediments are distributed. In the later research, Lőrenthey (1900) excluded the freshwater Pliocene Levantine beds from the Pannonian stage. Consequently, the final phase of the Pannonian was represented by caspibrackish Pliocene sediments. The Lake Pannon evolved from the Central Paratethys (Magyar, 1999), with salinity change from mesohaline to (caspi)brackish environment" (Ćalić et al, 2012a). The Pannonian Basin was in the use by geographers and geologists who used in different contexts moreover it was quite defined in the paleogeographical context.

Only sparsely the Pannonian Plain in former Yugoslavia used as an administrative unit by the geographic regionalization of former Yugoslavia lacking the priroties of the relief analysis: "The SAP Vojvodina and the East Croatian plain (Rogić, 1964, 1974; Rogić & Žuljić, 1972) comprise the Yugoslav part of the true Pannonain plain. This true Pannonian macroregional complex is especially clearly marked out as a third entity. The transitional character of the East Croatian plain, however, does not lesser justifiably of including it in the zone of the true Yugoslav Pannonian plain". (Rogić, 1980 p. 24). Same subdivision to the regions we can find in the Great Atlas of Yugoslavia (Bertić & Križovan, 1987) where to the Pannonian Plain assign the Eastern Croatian Plain and Vojvodina.

This paper focused on the definition the Pannonian Plain as a landscape / physico-geographic unit due to the relief and surficial geology. The main developments were the papers of Ćalić et al. (2012a, 2012b), with the definition of the Pannonian Plain based on geomorphological methods used morphometric aspects of relief. Due to this method was restricted within the national borders of Serbia (Fig. X) the results of this study shown the whole area of the Pannonian Basin System (Fig. 3 and Fig. 4).

Discussion on the subdivision of the Pannonian Plain

The priority during the subdivision were the macro landscape units: (Vienna Basin, Little Alföld and Alföld). All three smaller units are linked with the Alföld (defined *sensu* Gaudenyi & Mihajlovic, submitted B) they are Inner Somogy, western Drava Plain and Upper Sava Plain. The main macro landscape units are well defined, and the references are available, however the for the smaller should give further information:

The Inner Somogy is located in between the Balaton (north boundary) and the Drava Plain (south boundary). It represents on of the main blown sand area of Hungary. The Inner Somogy sand area is belived to be the oldest, whose formation could have started as early as the beginning of the Pleistocene, although the evidences have been found only about wind blown sand movements from the Late Pleistocene and Holocene (Marosi, 1970; Lóki, 1981). The PaleoDanube took its present flow direction about 30,000 years ago in the Danube-Tisza Interfluve, which means that the formation of the wind blown sand could start in the northen part of Inner Somogy. The northern part of Inner Somogy described as the eolian erosional zone of the alluvial fan (erosive winds from the north) which is characterized by blowouts, residual ridges and deflation flats (Lóki, 1981). The accumulation forms in the southern Inner Somogy are parabolic dunes they are often superimposed each other. Due to the intensive agriculture the dunes became smaller because of run-off erosion (Kiss, 2017).

The Drava Plain along its riverbed the Drava built a board floodplain (in Slovenian: *Podravlje*; in Croatian: *Podravina*). Meanders at various stages of development and heavily affected by river regulations works are typical particularly along the Hungarian-Croatian course (Lóczy, 2019). In the area of Drava basin the sediments derived from lacustrine deposition in Lake Pannon until 6.8 Ma ago, from this time a south-eastward prograding delta system controlled sedimentation (Haas, 2012). In the Pleistocene, the Drava already followed the west-northwest to east-southeast directed axis of the depression, which was gradually shifting in southwestern direction. The eastern lowermost part of the Drava Plain is a part of Alföld (fot the delineation of the Alföld see Gaudenyi & Mihajlović, submitted B) while the western Drava Plain is an independent landscape segment of the Pannonian Plain.

The Upper Sava Plain formed in the Holocene in the Sava through. It is composed of fluvial sediments along its course from the Podsused Gate till the Brod Gate (*sensu* Gaudenyi & Mihajlović, submitted B) mainly wide floodplains, alluvial fans (mouths of numerous Sava River tributaries). The Lower Sava Plain is a part of the Alföld (*sensu* Gaudenyi & Mihajlović, submitted B).

Conclusions

The Pannonian Plain is a landscape or physico-geographic unit. It encompass the plain lowland landscapes of the Pannonian realm, from Kroneuburg till the Iron Gate. According to the surface rougness classes and relief cahrecteristics, six segments of the Pannonian Plain identified (Table 1).

The Pannonian Plain has no synonyms. the terms Pannonian Basin, Pannonian realm, Pannonian Basin System as well as the Carpathian Basin have different meanings.

Table 1. Six segments of the Pannonian Plain (in English and Serbian)

	Segments of the Pannonian Plain	*Segmenti Panonske nizije*
1.	Vienna Basin	*Bečki basen*
2.	Little Alföld	*Mali Alfeld*

3.	Alföld	*Alfeld*
4.	Inner Somogy	*Unutrašnji Šomođ*
5.	western Drava Plain	*zapadna Podravska nizija*
6.	Upper Sava Plain	*Gornja posavska nizija*

The Pannonian Plain has no synonyms. the terms Pannonian Basin, Pannonain realm, Pannonian Basin System as well as the Carpathian Basin have different meanings.

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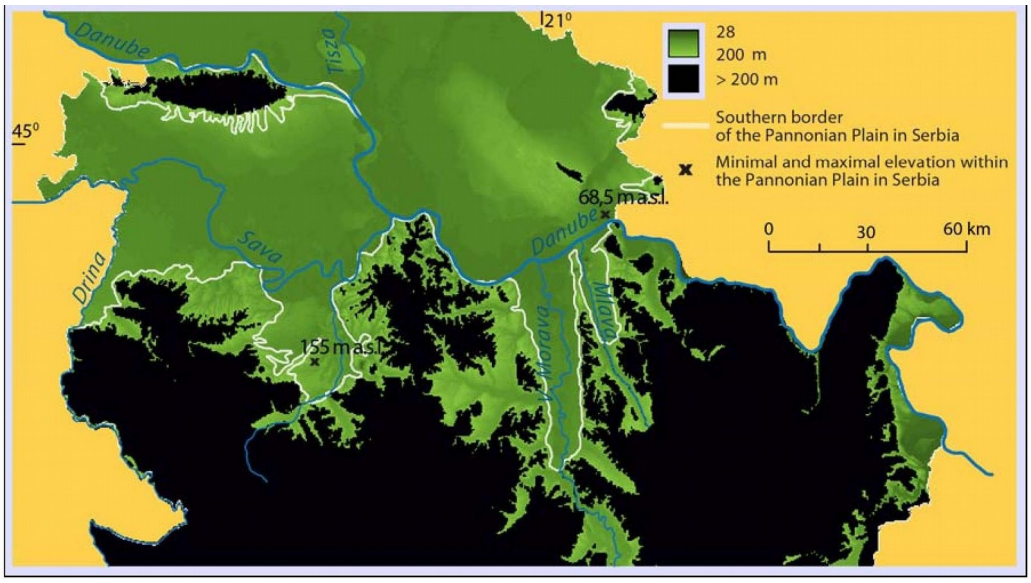
Figure captions:

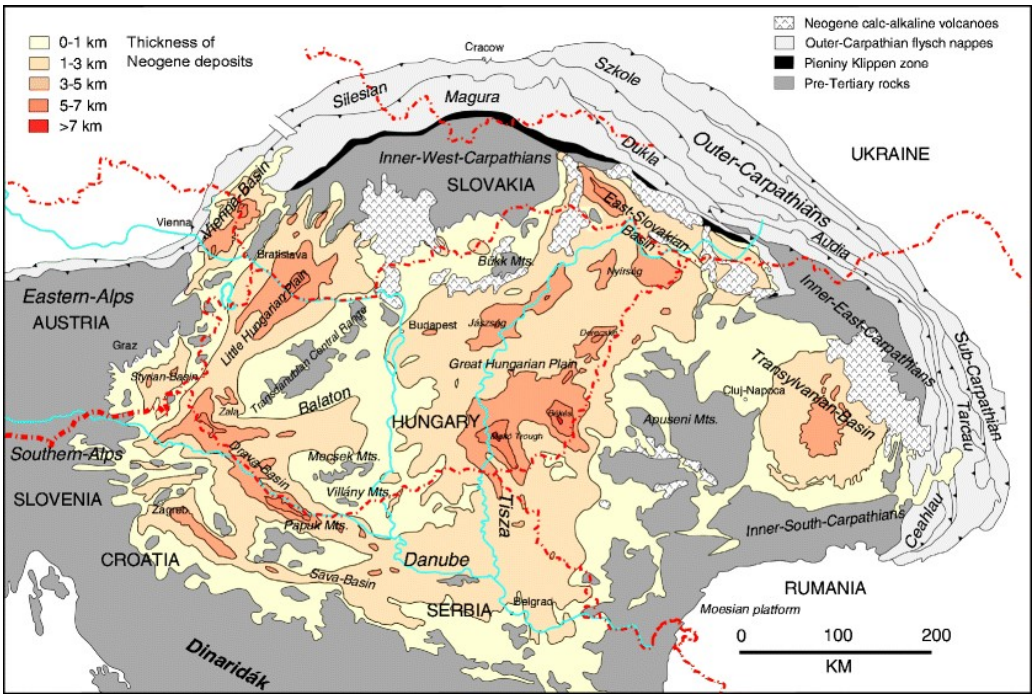
Figure 1. The Serbian segment of the Pannonian Plain (cropped from Ćalić et al. 2012a).

Figure 2. Thickness of the Neogene deposits of the Pannonian Basin System. (source: Hámor et al, 2001 identical as in Nagymarosy & Hámor, 2012)

Figure 3. The delineation of the Pannonian Plain based on roughness classification classes examined with QGIS software. (WHOLE PAGE)

Figure 4. The delineation of the Pannonian Plain based on roughness classification classes examined with QGIS software.


Danube
Tisza
21°
45°
28
200 m
> 200 m
Southern border
of the Pannonian Plain in Serbia
Minimal and maximal elevation within
the Pannonian Plain in Serbia
68.5 m a.s.l.
Danube
0
30
60 km
Drina
Sava
Morava
Velika
Morava
155 m a.s.l.


0-1 km
1-3 km
3-5 km
5-7 km
>7 km
Thickness of
Neogene deposits
Neogene calc-alkaline volcanoes
Outer-Carpathian flysch nappes
Pieniny Klippen zone
Pre-Tertiary rocks
Cracow
Silesian
Magura
Szkole
Dukla
Outer-Carpathians
UKRAINE
Inner-West-Carpathians
SLOVAKIA
East-Slovakian Basin
Audia
Vienna
Vienna Basin
Bratislava
Bükk Mts.
Nyirség
Eastern-Alps
AUSTRIA
Graz
Little Hungarian Plain
Budapest
Jászság
Great Hungarian Plain
Inner-East-Carpathians
Sub-Carpathian Tarcău
Styrian-Basin
Transdanubian Central Range
Balaton
HUNGARY
Cluj-Napoca
Transylvanian-Basin
Apuseni Mts.
Southern-Alps
Drava-Basin
Mecsek Mts.
Villány Mts.
Tisza
SLOVENIA
Zagreb
Papuk Mts.
Inner-South-Carpathians
Ceahlau
CROATIA
Danube
Sava-Basin
RUMANIA
Belgrad
SERBIA
Moesian platform
Dinaridák
0
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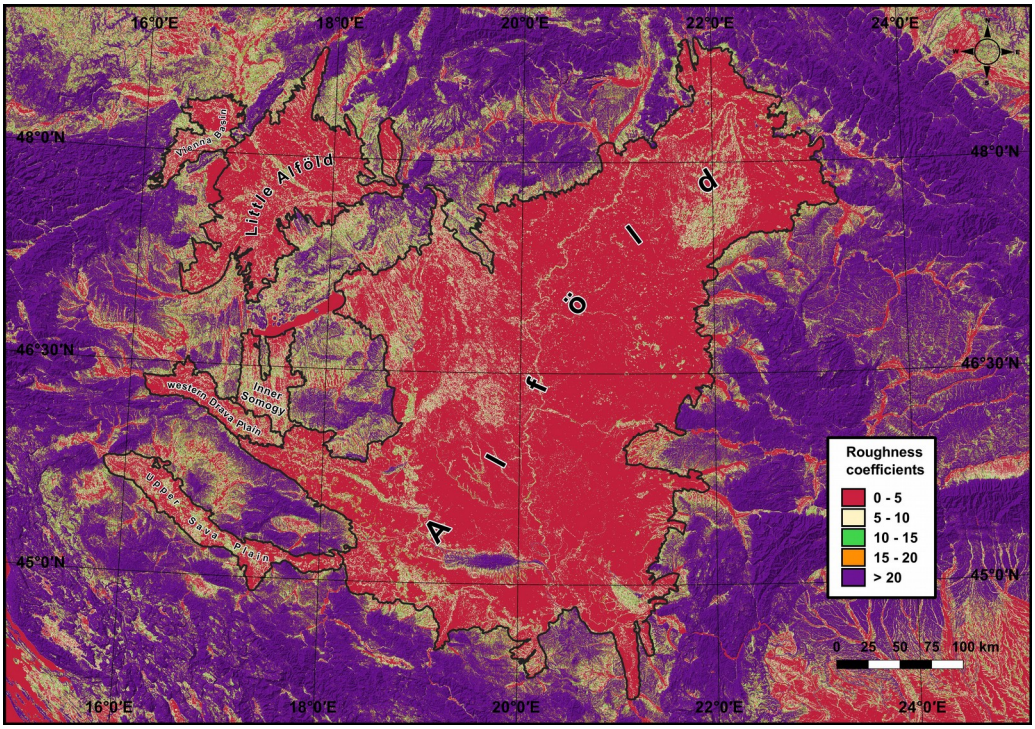
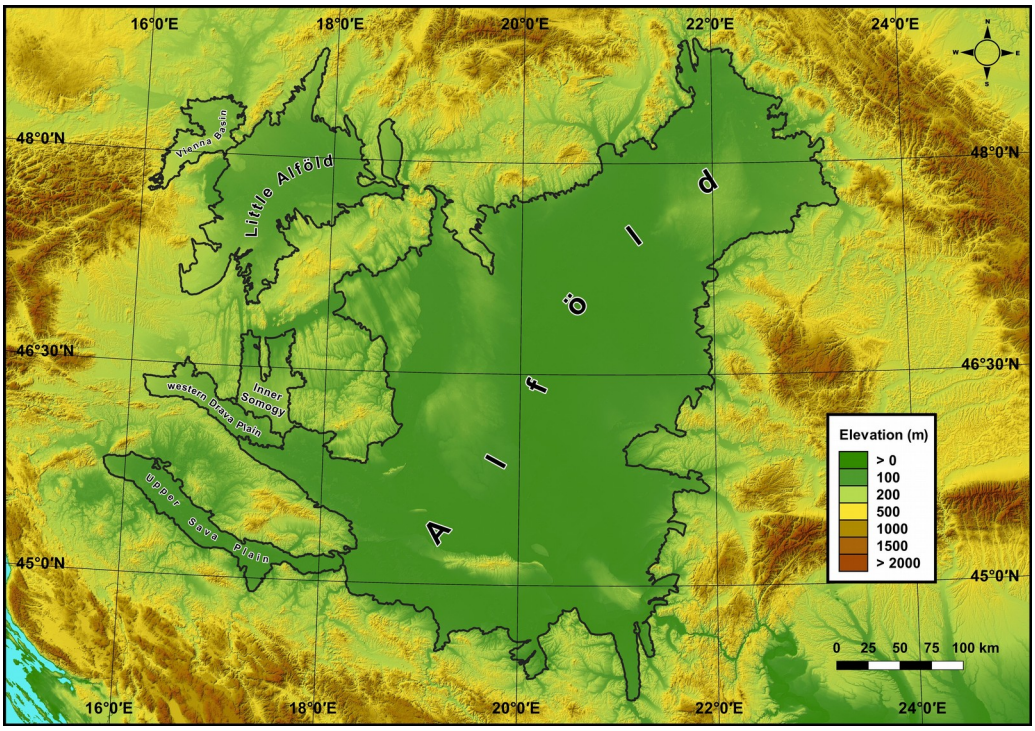
KM


16°0'E
18°0'E
20°0'E
22°0'E
24°0'E
48°0'N
46°30'N
45°0'N
Vienna Basin
Little Alföld
Inner Somogy
western Drava Plain
Upper Sava Plain
A l f ö l d
Roughness coefficients
0 - 5
5 - 10
10 - 15
15 - 20
> 20
0 25 50 75 100 km


16°0'E
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Vienna Basin
Little Alföld
Alföld
western Drava Plain
Inner Somogy
Upper Sava Plain
Elevation (m)
> 0
100
200
500
1000
1500
> 2000
0 25 50 75 100 km