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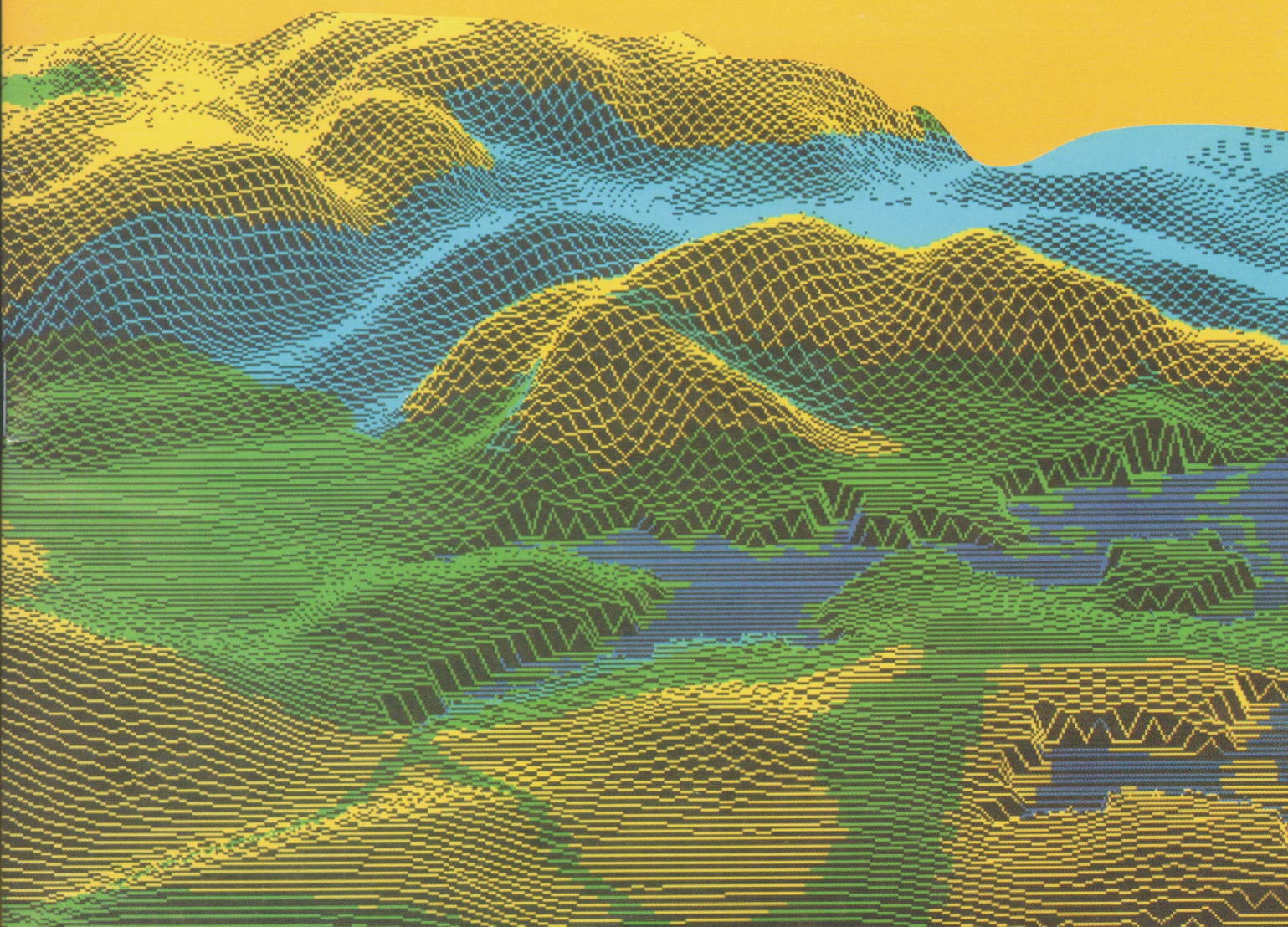

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Contents

Articles

Reports

ANTHROPOGENIC TRANSFORMATION OF RELIEF IN THE GABČÍKOVO WATERWORK AREA (SW SLOVAKIA)

Ján LACIKA

Abstract

This contribution deals with the problems of dynamics of the anthropogenic relief transformation in the Gabčíkovo Waterwork area. The Gabčíkovo Waterwork was built in the period from 1971 to 1992 on the Danube River by former Czechoslovakia and Hungary (Vidra ed., 1990). Three stages of the anthropogenic relief in the research area were analysed; prior the construction works (1970), during building of the waterwork (1991) and after the construction (1995).

Landforms were subject to the following monitoring: functional classification, analysis of the area distribution (mapping), evaluation of the intensity of the anthropogenic relief transformation, correlation of maps mapped in various periods.

Shrnutí

Antropogenní transformace reliéfu v oblasti vodního díla Gabčíkovo na jihovýchodním Slovensku.

Článek se zabývá problémy dynamiky antropogenních transformací reliéfu v oblasti vodního díla Gabčíkovo vybudovaného v letech 1971-1992 na Dunaji bývalým Československem a Maďarskem. Jsou analyzovány tři etapy výzkumu antropogenních transformací reliéfu: 1. před začátkem stavby (1971), 2. během stavby (do r. 1991), 3. po uvedení do provozu (1995). Tvary byly analyzovány z hlediska funkční klasifikace, plošného rozmístění, intenzity antropogenní transformace a srovnání map z jednotlivých období.

Key words: anthropogenic geomorphology, transformation of landforms, the Gabčíkovo Waterwork

1. Introduction

The contribution presents the problems of dynamics of the anthropogenic relief transformation as a partial indicator of the anthropogenic landscape transformation. This process is demonstrated in the Gabčíkovo Waterwork area.

2. Method

The process of evaluation of the dynamics of the anthropogenic relief transformation has its functional and chronological aspects. Both were used in the following four steps.

a) functional classification,

b) mapping of the area distribution,

c) evaluation of the intensity of the anthropogenic relief transformation,

d) correlation of the maps set-up in different periods of time.

The first step of this methodology is directed to the elaboration of functional classification of the occuring anthropogenic landforms (communal, urban, agricultural, etc.).

Detailed geomorphological mapping takes through the second step. The map legend is generated according to the previous landform classification. There are two ways of the mapping mentioned in this contribution. Mapping of the last stage of anthropogenic landforms is

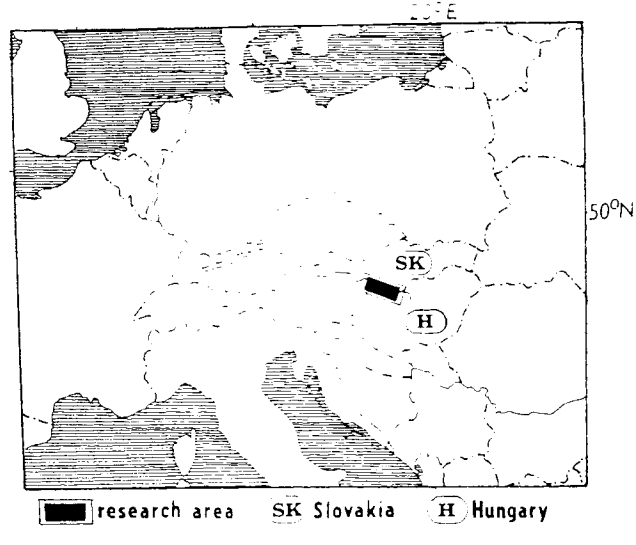

Fig. 1 Location of the Gabčíkovo Waterwork

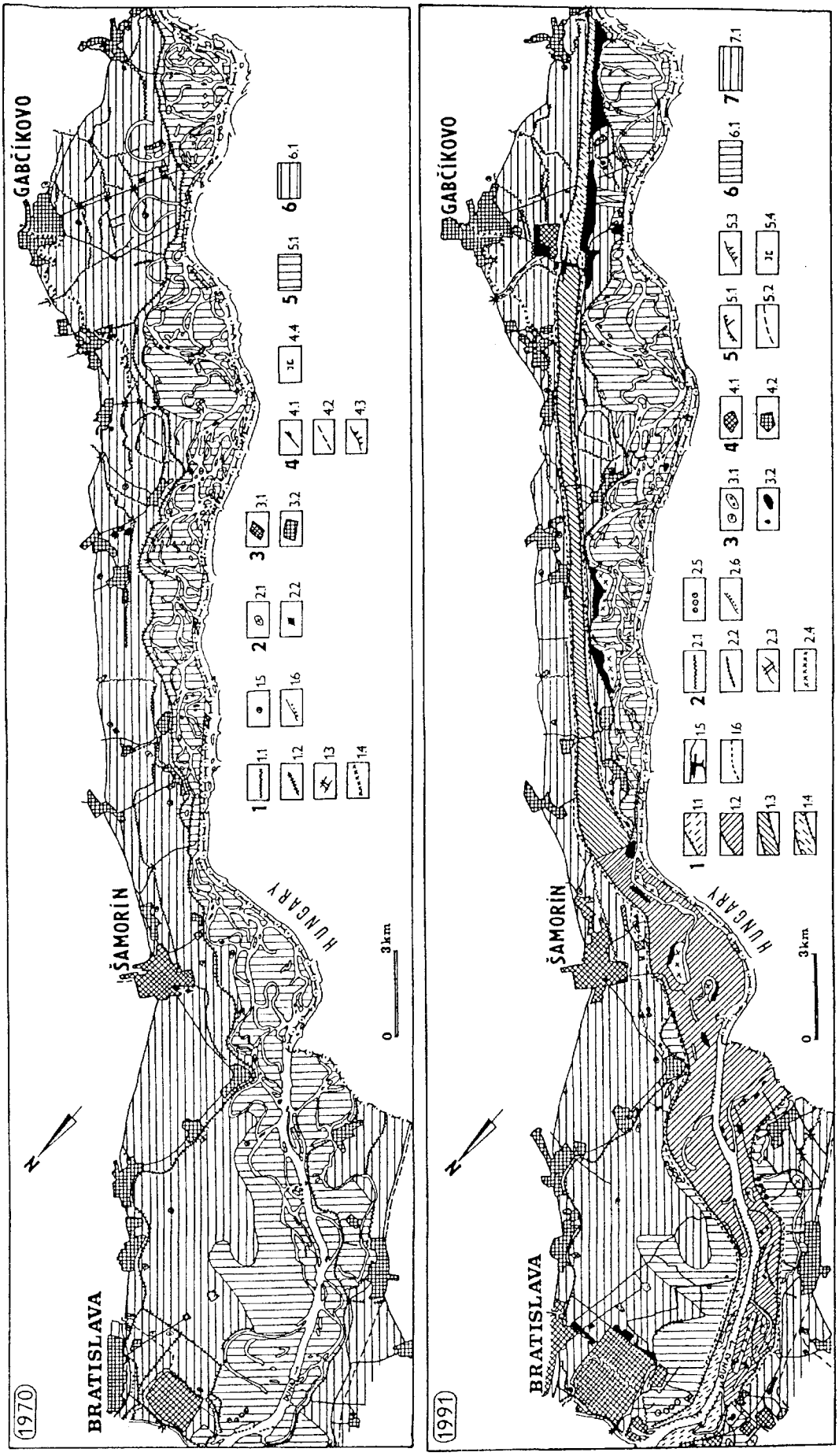

Fig. 2 Antrophogenic forms in the area Gabčíkovo

made from the topographical maps (taking into consideration the quality and scale of older maps). Mapping of the present anthropogenic landforms is made in the field with a sketching of the results into the topographical map 1:10 000.

The third step evaluates the classified and mapped landforms according to the intensity of anthropogenic relief transformation. The evaluation uses quantitative (volume, height, length, etc) and qualitative (used material, hardness, building costs, etc.) characteristics of the evaluated landforms. The landforms are given into 4-6 levels of the intensity of anthropogenic relief transformation and shown in the maps.

The final fourth step correlates the final maps showing the mapped information in different periods. It must accept a variability of the correlated maps according to their completeness and scale. The result of these correlations shows time and spatial dynamics of anthropogenic relief transformation.

3. Brief geomorphological characteristics

3.1 Morphometry

The research area is included into the Podunajská Rovina Plain (partial unit of the Podunajská Nížina Lowland). Its name shows the morphometrical properties of this area. The whole area is flat with relief dissection less than 5 m/km^2. The highest denivelation has been made by human activities only. The slope inclination is less than 1°. The Danube riverbed declines very gently from 0,16 to 0,57° (Tab. 1). There is a gentle convexivity in the transversal profile. The Danube riverbed is situated on the top of the flat convex curve. Top of this curve near Bodíky village is 5 meter high.

3.2 Morphogenesis

Three basic groups of processes have taken part in the creation of the research area morphogenesis: different tectonical subsidence, aggradation of fluvial deposits and human activity (Lacika - Stankoviansky, 1991).

In terms of its morphostructure, the research area can be characterized as a large tectonical depression - Žitný Ostrov graben, subsided along the complicated system of active faults. It is a typical graben filled by with Pliocene and Quaternary fluvial deposits (Halouzka, 1977 and 1993). Thickness of these deposits increases from the periphery towards the centre of the Žitný Ostrov graben. There are 15 m of deposits in Bratislava (Vaškovský, 1986) and 300 m close to Dunajská Streda (Buday, 1967). Step-like subsidence towards the transversal dirrection is not so good investigated. A very significant seismic fault has bordered the Žitný Ostrov graben from NE.

Morphosculpture of the research area has been created by Danube river fluvial activity (Halouzka, 1994). It was influenced by spatially changed morphostructural properties and timely changed morphoclimatic properties. The Danube river was forced to aggraded by changed morphotectonics between the uplifted Malé Karpaty horst and the subsided Žitný Ostrov graben. Out of the horst, the Danube river created a large alluvial fan (inland delta), built by a thick complex of sands, gravels filled with underground water. There is a very close hydraulic connection between the river and the underground water (Lehotský - Otaheľ - Grešková, 1990). The inundation belt along the Danube river was very wide before the human impact in this natural landscape. Old maps show it very good. The original fluvial process unlimited by men created a dense network of riverbeds and river arms. It was unequable. Some areas were filled slowlier and formed shallow wet depressions with marshes (Lukniš - Mazúr, 1959). Later, inundation dams reduced the areas of active fluvial processes into narrow belts along the Danube and the Malý Dunaj riverbeds.

4. Anthropogenic relief

4.1 Anthropogenic relief transformation until 1970

People have already changed landscape since the Neolithic Period. However, the essential landscape transformation occured only during the 19th century. There are natural stages of the research area in the old maps from the 18th century, which express a naturally branched Danube river without being influenced by human activities.

The great relief and lanscape transformations begun in the end of the 19th century. The people living close to the Danube river started to build the first levees, irrigation canals and regulate the natural river banks. The natural landscape was pressed into the inundation levees. The originally natural landscape outside this inundation belt was changed into agricultural and urban landscapes.

4.2 Anthropogenic relief - the situation in 1970

The stage of anthropogenic relief of the research area in 1970 was identified by topographical maps 1:10 000. Results of this mapping are shown in Fig. 2 (above) with the following legend:

1. Water management landforms

1.1 irrigation canals
1.2 levees
1.3 dams
1.4 regulated riverbeds and river arms
1.5 wells
1.6 regulated (reinforced) river banks

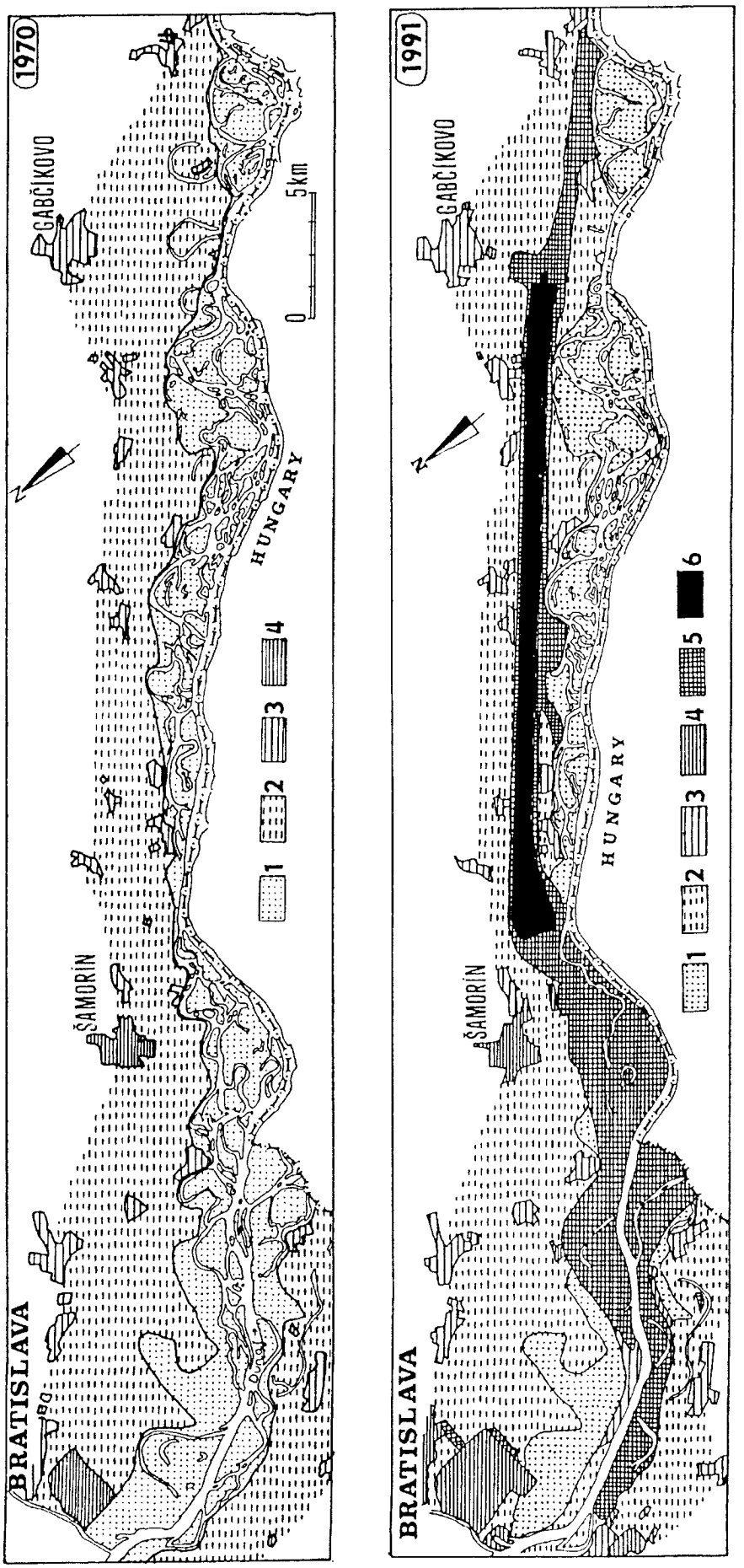

Fig. 3 Intensity of antrophogenic relief transformations

2. Outputting and communal landforms
2.1 gravel pits, sand pits and loam pits
2.2 taluses and dumps
3. Urban landforms
3.1 relief transformed by building activity of urban type
3.2 relief transformed by building activity of rural type
4. Communication landforms
4.1 reintorced roads
4.2 railways
4.3 directing dams into riverbed
4.4 bridges
5. Forest landforms
5.1 relief partly transformed by forest management
6. Agricultural landforms
6.1 relief partly transformed by agricultural activity

There was mainly a system of levees and irrigation canals in the research area in 1970. The system of levees had two different parts. The upper part levees was situated far from themain Danube riverbed (more than 5 km). A much complicated levee network was built round the big petrochemical factory - Slovnaft. The levees in the lower part narrowed to the riverbed and the inundation belt was very narrow (less than 2 km). Small dams were built inside of the inundation belt in 1970. Regulations of the river banks were rare.

Mapping of the distribution of surface mining and communal landforms in 1970 depended on the quality of information in the topographical maps. Several gravel pits, sand pits, loam pits, taluses and dumps were identified, particularly those located close to settlements. There were mostly rural type of settlements with less anthropogenic relief transformation. Šamorín and specific industrial Slovnaft area were identified as urban types of the settlement with more anthropogenic relief transformation in 1970. The communication landforms (the situation in 1970) included the reinforced roads, railways, bridges and special dams to improve the river transport condition inside of the Danube riverbed.

There are four intensity levels of the anthropogenic relief transformation in the map (Fig. 3 - above) shown in the situation in 1970. The lowest intensity was identified in the alluvial forest inside of the inundation belt. The highest intensity can be found in the areas of urban type settlements.

4.3 Anthropogenic relief - the situation in 1991

Construction of the Gabčíkovo waterwork changed the landscape under study very much. The stage of the anthropogenic relief transformation is shown in Fig. 2 (bellow) with the following legend:

1. Multifunctional landforms (waterwork)
1.1 less anthropogenically transformed relief of the future basin
1.2 more anthropogenically transformed relief of the future basin
1.3 inlet canal
1.4 outlet canal
1.5 power plant and lock chambers
1.6 soak canals
2. Water management landforms
2.1 irrigation canals
2.2 levees
2.3 dams
2.4 regulated riverbeds and river arms
2.5 wells
2.6 regulated (reinforced) river banks
3. Surface mining landforms and communal landforms
3.1 gravel pits, sand pits and loam pits (dry and wet)
3.2 taluses, dumps and filled depressions
4. Urban landforms
4.1 relief transformed by construction of urban type
4.2 relief transformed by construction of rural type
5. Communication landforms
5.1 reintorced roads
5.2 railways

Tab. 1: Longitudinal profile of the Slovak Danube riverbed (k. ú. = cadastral district)

POINT of PROFILE	km from MOUTH	ALTITUDE m	GRADIENT m/km
Morava mouth	1880	139.6	-
Devín (quarry)	1878	139.2	0.20
Wolfsthal	1875	138.6	0.20
Karlova Ves	1872	134.1	1.50
Most SNP Bridge	1869	132.3	0.60
Rusovce	1856	129.5	0.22
Čuňovo	1851	128.2	0.33
border SK/H	1850	126.5	0.43
k.ú. Vojka	1836	121.1	0.38
k.ú. Vojka	1833	120.6	0.16
k.ú. Horný Bar	1825	118.0	0.33
k.ú. Baka	1821	116.3	0.43
k.ú. Sap	1811	114.9	0.14
k.ú. Medveďov	1803	113.2	0.57
Rába mouth	1796	110.3	0.34
k.ú. Zlatná n. O.	1781	108.1	0.14
Pavel	1775	107.2	0.18
k.ú. Nová Stráž	1772	106.9	0.10
Váh mouth	1766	106.6	0.05
k.ú. Patince	1755	106.2	0.04
k.ú. Moča	1746	105.9	0.03
k.ú. Mužla	1730	105.8	0.01
k.ú. Štúrovo	1723	104.4	0.20
k.ú. Štúrovo	1718	103.6	0.16
Hron mouth	1716	103.2	0.20
k.ú. Kamenica n.H	1712	102.7	0.13
Ipeľ mouth	1708	101.6	0.28

5.3 directing dams into riverbed

5.4 bridges

6. Forest landforms

6.1 relief partly transformed by forest management

7. Agricultural landforms

7.1 relief partly transformed by agricultural activity

The Gabčíkovo Waterwork had several different parts in 1991. Most of them had not beenfinished during the mapping period. There was a future dam bordered by stone and concrete wall in the upper part of waterwork. The bottom of the future basin was dry during the mapping period. There were many of gravel pits identified on the bottom of the future basin. The central part of the waterwork was formed by an inlet canal up the power plant and lock chambers. An outlet (hollowed) canal was built downstream of them, returning the Danube water into the old riverbed. It was filled with underground water. The whole waterwork was bordered by a long system of soak canals.

The landscape changes were identified not only inside of the building-plot area bull less. New connections between the irrigation canals and soak canal had to made. The urban, surface mining and communal landforms grew larger.

The intensity of anthropogenic relief transformation is shown in Fig. 3 (bellow). The number of levels was increased from 4 to 6. The highest intensity was identidied in the area of the waterwark built of stone and concrete (inlet canal, power plant, lock chambers). The second highest intensity had most of the future basin, soak canals, outlet canal, the biggest pits and taluses in the research area. In 1991, the remaining area had a similar level of intensity of the anthropogenic relief transformation as in 1970 (besides the new districts on the margin of Bratislava and the extended Slovnaft area).

4.4 Anthropogenic relief transformation during the 1970-1991 period

There were pronounced changes of anthropogenic relief in the research area during the 1970-1991 period, connecting with building of the Gabčíkovo Waterwork. This is documented by the comparison of maps in Fig. 3. The area of the lowest intensity of anthropogenic relief transformation was very much reduced. In contrast, the areas with two highest intensities of the anthropogenic relief transformation were a new. Other differences are shown in Fig. 3.

4.5 Anthropogenic relief - the situation in 1995

The detailed mapping was not made after 1991. The maps were up-dated betwen the planned building of the waterwork and after filling the basin and canals. The Gabčíkovo Waterwork was put into operation in 1992. To Hungarian comments the project of the waterwork was changed. The dam holding the basin was moved. This was the cause to the reduction of the basin area and a lengthening of the inlet canal.

5. Conclusion

The Gabčíkovo Waterwork area gives a good example of an extraordinary anthropogenic relief transformation. It will be necessary to authorize the methodology of this contribution in different types of landscape and use it later as a very sensitive indicator of anthropogenic landscape transformation.

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