PHYSICAL-GEOGRAPHICAL CHARACTERIZATION OF THE RUNNING WATERS OF THE SOUTH-EAST HUNGARIAN PLAIN

M. ANDÓ

Development of the surface water courses

The development of the water network of the South-East Hungarian Plain proceeded in parallel and in close connection with the development of the surface. At the beginning of the Pleistocene certain areas of the Plain jerked down to various depths. This tectonic phenomenon at the same time also governed the then prevailing picture of the running-water network. This was the time of the separation of the Berettyó section of the Szatmár—Baja break, the Pleistocene basin between the White Körös and the rim of the Plain (the area of the later Sárrét), and the depression of the Zagyva—Tisza trench between Csongrád and Szolnok and Csongrád and Szeged (SÜMEGHY J. 1944, SOMOGYI S. 1960). For the greater part the depressions were filled up with running-water alluvium. The filling-up may have been intensive, so much so that the depressions became completely filled, and on the surface only the main water run-off and the temporarily water-storage deep lines remained. By the middle of the Pleistocene, the hydrographic picture of the Hungarian Plain had changed. The Zagyva—Tisza trench was completely filled up, and consequently the running waters originating from the Northern Hills and their alluvial slopes flowed into the deep-line of the Ér, Berettyó and Körös. The enormous depression of the Sárrét attracted all of the running waters in the area east of the Tisza. This is where the streams of the Mátra and the Bükk flowed, the Tarna, Gyöngyös, Eger, Laskó, etc. In the Pleistocene the alluvium of the waters of the Mátra and the Bükk extended across to the present left bank too of the Tisza (SÜMEGHY J. 1944, RÓNAI A. 1956, SOMOGYI S. 1961, URBANCSEK J. 1961). Naturally, the ancient channel beds and sediments came under the thick overspill cover of the Tisza in the Holocene, but even then the hydrographic picture of the old running waters was inherited in the surface microforms. For example, right up to the time of the river-regulation the floodwaters of the Tisza found their way down towards the depression of the Sárrét across the beds of the one-time branches of the Sajó and the Hernád (Kadarcs, Selypes-ér, Árkus-ér, Száraz-ér, etc.). (LÁNG S. 1944—47, PAPP A. 1956).

The trough of the Körös rivers was therefore a considerable erosion base of the running waters of the district. This phenomenon is very well reflected in the talus developments too, for these regularly flank the depression zones of the Ér and the Berettyó. The talus of the Körös and of the Maros lie on the area of the county. Since the ancient rivers filled up the deeper parts only gradually, even in the Pleistocene the run-off courses of the rivers by and large followed denoted lines.

The further subsidence of the Hungarian Plain also led to a great change in the ancient hydrographic picture of the area in the Old-Holocene. For example, the stepped down-dip which occurred on the berm levels of the rim-hills was the main agent in the development of the hydrographic picture of the county. Substantial subsidence took place particularly on the areas of the Ér-mellék, the Ecsedi-láp, the Bodrogköz, the Tokaji-kapu, the Takta-köz and the South Jászság fore-depressions. Consequently, the rivers Szamos and Kraszna now flowed into the trough of the Ecsedi-láp and not into the valley of the Ér, as previously. The running waters of the Northern Hills, flowing towards the trough of the Ér, the Berettyó and the Körös rivers, were drained off by a series of fore-depressions of the Vásárosnamény—Szolnok section of the Tisza. As a consequence of the rim subsidences, the hydrographic axis of the Hungarian Plain in the Old-Holocene became the Tisza, while the deep-line of the Ér, Berettyó and Körös (which still had a considerable run-off area in the Pleistocene) lost much of its importance.

Significant changes also occurred as regards the state of the ancient Maros river. Even in the Pleistocene, the Maros sought its way in various branches across its self-built talus, whereas in the Old-Holocene the Maros occupied its present position. One-time beds such as the Száraz-ér and Aranka, for instance, remained in a dependent situation and slowly faded away. (Fig. 1.) Especially the northern branches of the Maros (Száraz-Ér) were the water-courses which for a long time transported the water to the district between the Körös rivers. This connection remained virtually up to the present day (up to the river-regulation) (MÁRTON GY. 1914, LÁNG S. 1960, SÜMEGHY J. 1944, SOMOGYI S. 1969).

Hydrographically, two different types of terrain can be distinguished on the area of the south-eastern Hungarian Plain: the floodwater-free Pleistocene terrain comprising the "high-level" of the Békés plain, and the "low-level" Holocene terrain of the deep-lying area. Mutually different conditions can be observed between the two areas as regards the natural water-network, both systematically and on the basis of their hydrographyc natures. While the loess table-land of the Békés plain (the high level) is poor in surface waters, the low level is an area rich in waters. The scarcity of water on the table-land is mainly caused by the hydrogeological factor. The sediment on the surface (sand, loess) is a good water-conductor, and a further contributory factor is that the surface loess lies immediately above a very thick sand layer. Consequently, the impermeable layer is missing even in the deeper levels. The precipitation falling on the surface readily infiltrates into the subsoil or into the porous layer storing the groundwater, as a consequence of the nature of the surface. Hence, the surface erosion was of a low extent here, and conditions were unfavourable for the development of surface water-courses. At present the area has no natural living water-courses; by and large periodic water run-off occurs in the beds and morotvas of the old, abandoned river-beds, or in their relatively deeper-lying inclines. The directions of the periodic water-courses run out radially, corresponding to the talus nature, to the rim rivers. One such more important periodic water-course is the Száraz-Ér, the well-formed bed of which is even accompanied by an Old-Holocene terrace. On the occasion of the river-regulation the Száraz-Ér was sealed off at the withdrawal from the Maros, and it now receives only a determined water yield from the Maros via the constructed sluice system. In years with high precipitation, a considerable amount of water (8—10 m^3/sec) flows in the bed of the Száraz-Ér. Not only does it collect the local precipitation water, but it also receives a substantial groundwater replacement from the area over the border. As far as Békéssámson the Száraz-ér is generally north-west in direction, but from

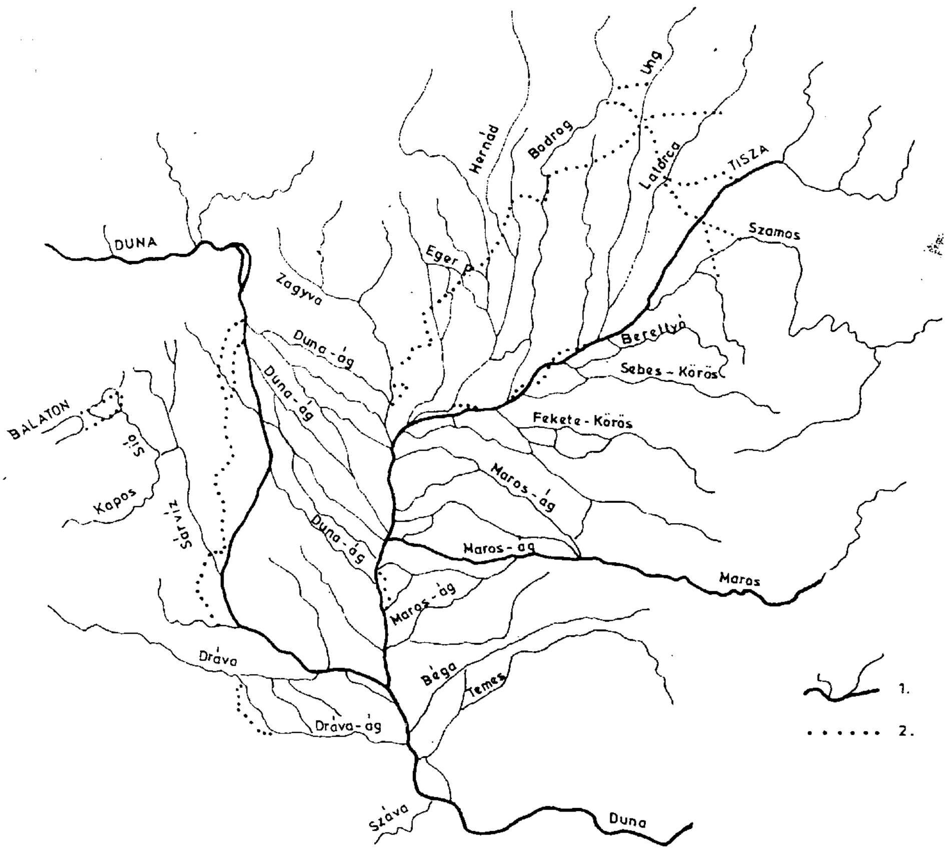

Fig. 1. The water-system of the Hungarian Plain
1: river 2: boundary

here it turns to be south-west. Numerous collecting channels empty into its fairly well-formed bed. The more notable include the Tótkomlósi-ér, the Aranyadi or the Medgyesbodzási main channels, etc. Several older Maros river branches can be found parallel to the Száraz-ér on the northern wing of the talus. These residual beds can be used as inland-water catchments, but they are also very suitable for channel development. Examples are the Kórógy-ér main channel, which leads across the Kurca into the Tisza, and the Hajdú valley stream network (Hajdú-ér, Csorvás ér, Mágócs-ér, Szénás-ér).

The hydrographyc picture of the deeper alluvial area is completely different. Here the surface is totally evened-out as a consequence of the perfect fllling-up. The uniform filling-up and the very low surface slope had the result that, prior to elimination of the floodwaters, the running waters wandered freely, virtually without beds. They developed over-formed bends, and in places river valleys of a lower-section nature, and flowed at a slow rate towards their erosion base. A further consequence of the uniform filling-up was that watersheds did not develop between the rivers, and bifurcation between rivers was frequent at times of high water-levels. On flooding of the rivers, for instance, part of the water of the Tisza flowed across the through of the Hortobágy into the Körös, or the Körös was shortened towards the Tisza via the Veker-ér and the Kurca. However, it also occurred that the northern wild-arms of the Marostoo flowed into the plain of the valley of the Körös rivers. The rivers (generally of a middle-section nature), wandering freely before the river-regulation, wore away and indented by appreciable side-erosion the margins of the flood-free surfaces, and even dismembered certain areas. As a result of the change in position of the river beds and with the over-development of the bends, many river loops arose, and therefore the district of the present rivers is full of morotvas and river bends in various stages of development. Even on the occasion of minor flooding, the more low-lying areas generally came under water. As a consequence oı the extensive bends, the rivers were not capable of leading off their floodwaters. In certain regions, for example, stagnant waters and marshy areas were formed from one flooding to the next; the most extensive among these was the region of the Sárrét.

The hydrographic picture of the county changed considerably with the river-regulation and in the course of the other work transforming Nature. From the aspect of the social and economic life, the regulation was already indispensable. The numerous catastrophic floodings caused inestimable damage, not to mention the fact that the swamps and marshes were also directly harmful to the health of the human population.

Nationally, the idea of floodwater-prevention was first raised along the Körös rivers, since this area was that most endangered by flooding. The first consistent plan for the regulation of the Körös rivers was prepared in 1815. This was the plan by MÁTYÁS HUSZÁR, which later, in 1879, formed the basis for a new regulation plan. The regulation of the Körös rivers was completed by the turn of the century. The performance of work involving the movement of thirty million m^3 of ground and the cutting of 248 intersections meant that the length of the rivers was shortened from 1003 to 455 km. As a result of the transformation, the fall relations in the running-off of the rivers increased; the beds were deepened; the low-water level dropped by about 1 m; at the same time the floodwater level rose, and in parallel with this the rate of run-off of the floodwaters also increased. Nowadays, even the largest flood-wave passes down in 3 days, compared with a matter of weeks before the regulation; indeed, in certain areas the effects lasted for months. In the inland-water organization which accompanied the river-regulation, about 65 pumping stations and about 6000 km of inland channels were built. The first fram to employ large-scale irrigation in Hungary was situated here (Gyoma 1858). The extensive transformation changed the hydrographic picture of the district significantly.

Hydrogeographical conditions of the surface waters

As regards numbers, the alluvial area of the south-eastern Hungarian Plain is very rich in rivers; however, this is not the case with regard to the utilizable water reserves, for a considerable proportion of the rivers have a fast course and their water-level fluctuations are extreme. (Fig. 2.)

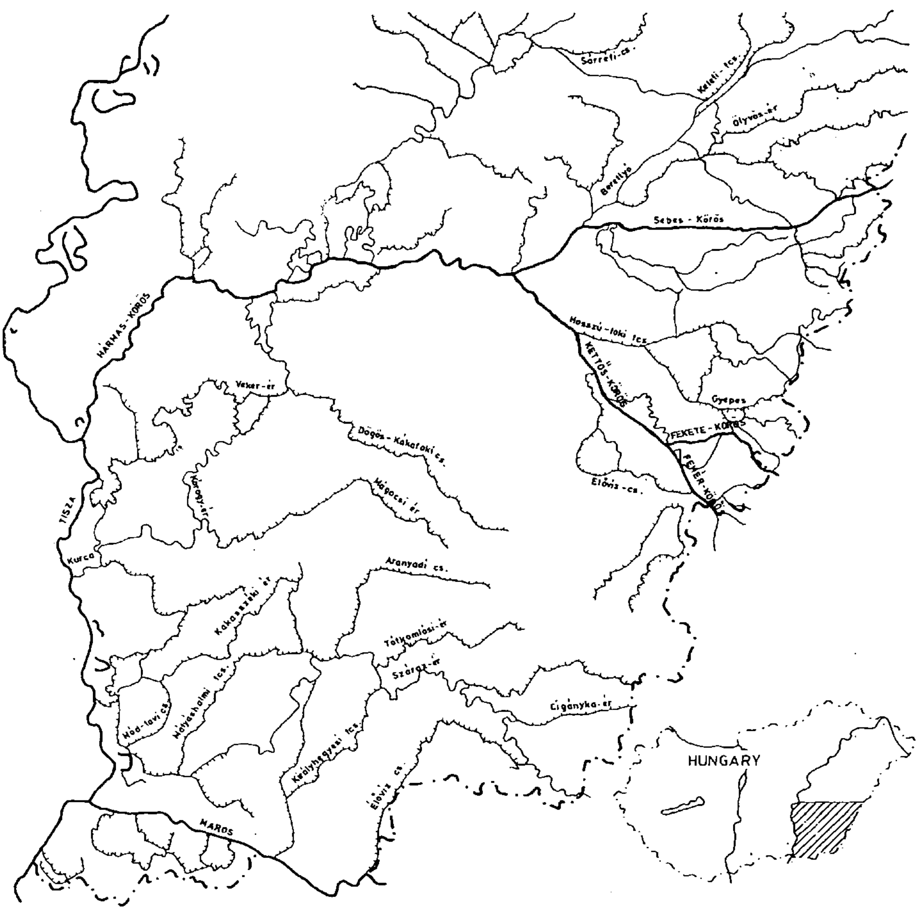

Fig. 2. The water-system of the South-East Hungarian Plain

The White Körös. This originates on the south-eastern slopes of the Bihar Hills. Its source is fed by many hill-streams. In its upper section the river falls from an average height of 1000—1200 m with the nature of a wild mountain-stream (17,5 m/km), and it contains an appreciable amount of water. The river reaches the Plain at Borosjenő in Romania, where its fall is now 0,5 m/km. At Gyula it is 0,2 m/km. From Gyula to the point where it unites with the Black Körös there is only a 5 km section, where the fall again increases, to 45 cm/km. From its source to its union with the Black Körös, the length of the river is 235,6 km. Its water-catchment area is 4275 km^2. Prior to the regulation it flowed with numerous branchings and bends, and as a result of the comparatively low fall conditions it inundated large areas with floodwater. The settlements and district of Gyula, Kétegyháza and Doboz were particularly frequently inundated by floodwater. Before the regulation, it united with the Black Körös in the vicinity of the village of Doboz (at Szanazug);

much earlier, this union took place below Békés, for the river floowed in the bedline of the present living-water channel, crossing the settlements of Gyula, Békéscsaba and Békés. Regulation of the White Körös was considered as long ago as the 17th century, in that it would be united with the Black Körös above Borosjenő. This plan did not materialize; instead, at the beginning of the 19th century a number of channels were dug along the river (in the county of Arad) in order to accelerate its course. However, this had the result that the rapid course led to the formation of large areas inundations and extensive marshes in the lower section of the river. As the first step in the regulation, the mill-dams built into the river were removed and were transferred to a special mill-channel built for this purpose (JÓZSEF NÁDOR *channel*). Simultaneously with the removal of the dams, bed intersections were created and the river was banked up on both sides.

This river-regulation gave rise to a "state of danger" as regards the county of Békés, and hence regulation and bed-cleaning were performed in Békés too. The regulation plan of 1855 mainly extended to the ordering of that section of the White Körös in the county of Békés. This plan was not carried out in the form of the original conception, the main cause of which was the large flooding in Gyula in 1855. That section of the Körös then passing through the town was resituated outside the town, in its present linear bed. With the construction of the Gyula—Békés Körös branch, the towns of Gyula and Békéscsaba did everything to obtain living water. In 1896 a storage dam was built at Gyula. This transformation was not suitable, as the led-off water eroded the bed-sides of the post channel to such an extent that the safety of the dam and the nearby flood-defence embankments was endangered. In the 1950-s the storage dam was reorganized, and the district is now in a reliable condition.

It is characteristic of the present quantity of water in the White Körös that its water yields at high-water, at low-water and at mean-water level are 605, 0,001 and 23 m^3/sec, respectively. The considerable changes in the water yield are typical of the variations occurring in the river. Its highest water yield occurs in spring, in the period after the melting of the snow, while the lowest water yield occurs in the autumn months. In the event of extremely dry weather in summer, it can happen that the bed dries out completely between the sluice at Gyulavár and the mouth. At present the alluvial transport of the river is insignificant; it transports only a very fine white mud, which gives rise to the name White Körös.

The Black Körös. In the district of its origin it develops from three spring-streams with ample water yield. Similarly to the White Körös, in its hilly section it is fed by many hill-streams. It arrives on the Plain after leaving the Bihar Hills near Belényes. Initially it flows in a narrow valley, in a rocky gravel bed, and then on a very sloping terrain, but in friable soil, up to the influx of the Tőz side-stream. The river exhibits frequent changes in direction in this section of its course. It bends first in a south-west to west direction, and then in a north-west direction. Below Tenke the Gyepes-ér (as a residual wild-branch) branches out from it in a northern direction. This stream system may at one time have been a large living-water course; this is indicated by the large river bends and the predominantly already filled-up wide flood-areas. In the depression lying to the south of the exit of the Gyepes-ér, the Black Körös encounters numerous interlaced streams (Leveles-ér, Szartósz-ér, Tőz, etc.) before reaching the national boundary. In the county, below the village of Doboz (in the area of Szanazug) it unites with the White Körös; from here it flows under the name of the Double Körös for a distance of about 37 km towards the valley-plain of the Fast Körös. The regulation of the Black Körös was completed in 1914, with the construction of about 78 intersections, with the establishment of flood-defence embankments at a minimal distance (120 m), and with dredging and bank-protection work between Szanazug and Tamásda. In its Hungarian section the fall of the river is on average 0,1 m/km. In its upper section it is 30—40 m/km, above Belényes 3 m/km, up to Tenke 1,3 m/km, up to Talpas 0,63 m/km, and up to Tamásda 0,26 m/km. The water-catchment area of the river is 4645 km^2, almost half of which is hilly area. The length of the present river is 167,7 km, while its valley length is 145,9 km. The Black Körös is very difficult to control by bank-protection, and very intensive bend development can be observed even in its currently regulated valley plain. Consequently, many bank-defence works have been constructed (Szanazug, Remetés, Sugar Factory, Malomfok, Mélyvárd, etc.) to protect the bed-side. The amount of water in the river is somewhat more uniform than that of the White Körös; on the occasions of the individual floodings, larger quantities of water are produced here than in the White Körös. At high-water, mean-water and low-water levels, the amounts of water are 572, 29 and 0,4 m^3/sec. At low-water level in summer there is a more favourable amount of water here than in the White Körös. The low-waters are of a subsiding tendency for the entire length of the river, and the high-waters are subsiding particularly up to the region of Belényes. Before the flood-regulation, the floodwater level of the Black Körös was 3,6—4 m higher than the lowest water level, and exceeded the banks by about 1,6 m. In the region at the mouth of the river, a considerable area came under water for a long time. In the upper section of the river the flooding and the ebbing lasted for 1 and 3 days, respectively; in its middle section for 4 and 14 days; and in its lower section for 6 and 30 days. The Double Körös formed from the confluence of the Black Körös and the White Körös. Its extreme water levels and yield depend on the quantities of water in the two Körös branches. From the aspect of water management the river is not stable, but with the insertion of retaining dams this was largely eliminated. The fall of the combined rivers is very small: 0,08 m/km up to the Békés section, and even less after this. Before the regulation, this part of the county had virtually no run-off. The river meandered strongly, and its over-developed large bend wandered widely throughout the Kis-Sárrét and its district. The difference between the lowest and the highest water levels of the river was around 6 m. In this section the flooding lasted about 14 days, and the ebbing 30 days. The annually-occurring high-flooding resulted in a water-coverage of about 1,6 m on the flood-plain. Frequently, the flood-waves originating from the summer rains overtook the spring flood-water, and hence the flood-plain was under water for practically the whole year.

The regulation work totally transformed the behaviour of the river, though some problems may still be observed at present. At Szanazug the river receives the flood-waves of the White Körös and the Black Körös with a large fall. Since there is a sudden decrease in fall in the linear Doboz section, the river deposits its muddy alluvium strongly here. Elsewhere, where there are unfavourable hydrogeological features, a series of bank erosions occur. In contrast, the bed of the Triple Körös is in an equilibrium state. The low water level of the Tisza in the section of its mouth, however, means that bank erosion arises here too.

The Fast Körös. This rises from a 700 m high layer spring at Körösfő in the western part of the Erdélyi-Sziget Hills. Its total length is about 209 km, and it possesses a water-catchment area of nearly 10 000 km². Its Hungarian section is only 59 km in length, and about one-third of the water-catchment area is related to this section. Its more important tributaries are the Jád, the Sebes, the Dragán and the Berettyó, but in addition numerous brooks and streams run into its water-catchment system. It unites with the Berettyó between Szeghalom and Körösladány. From here, with its wide, extensive alluvial flood-plain, it flows between high embankments at a fast rate to join the Double Körös. It is of great importance in the life of the river that in its upper section, beyond the national boundary, the fall of its bed-bottom is 19 times that of the fall in the lower, Hungarian section.

Section riv. km	Bottom level m above Adriatic	Bottom fall cm/km	Note
0	84	—	low-fall
57	95	19.3	Hungarian section
110	148	100	high-fall
160	352	408	Romanian section
175	465	755	
209	650	545	
0—209	650—84	271	average

As a result of the high flow rate, the river transports much alluvium, but its coarser alluvium is deposited before it reaches the border section. Prior to the regulation, the orderly development of the bed was prevented by mill-dams on the Fast Körös too. These appreciable promoted rapid flooding and protracted the ebbing of the flood-waves. Its present situation was created last century with the construction of 24 intersections and the Sárrét channel. The old Sárrét section plays a very important role in the life of the river. Here a bed was not dug at the time of the regulation; only a small künnet was established, bordered on both sides by embankments. Formation of the bed was left to the river, but this did not embed itself; just the opposite, the flood-plan and the bed are filling up. Consequently, a subordinate bed has developed in this section. Even though the present rate of filling-up is somewhat lower, a significant intervention is still becoming necessary in the river branch (dredging, bank-protection, etc.).

The name Triple Körös is given to the river-valley section interspersed with many over-developed bends and split-off bed-residues in the broad flood-plain after the confluence of the Double Körös and the Fast Körös (according to MENDÖL Z.). This river bed is the jointly formed valley of the ancient Szamos, Ér and Körös. On the regulation of the Körös system, the most extensive transformation had to be accomplished in this section of the river. After the regulation the flow of the river accelerated and its slope increased. Its water reserves remain below those of the Maros, but in spite of this its economic value is more enhanced, with the installation of storage dams. The storage dam at Békésszentandrás was completed in 1942, and with this the possibility arose for the irrigation of an area of about 25 000 km². Since the Second World War, extensive development has been carried out to extend the irrigation possibilities via the total exploitation of the currently available water reserves of the Triple Körös.

The Berettyó. Before the regulation, the river disappeared completely in the swamp of the Nagy-Sárrét to the west of Bakonyszeg, while it flowed with a large bend in the pre-mounth section. (in order to separate the river from the Sárrét, a new bed was dug from Bakonyszeg to the Fast Körös between 1854 and 1865. By this means the previously 146 km long section of the river was shortened to 32 km, and its fall increased considerably too. In the section below Berettyóújfalu, the fall is 0,1—0,2 m/km. Although the shortened river lost an appreciable water-catchment area, it still possesses one of the most significant water-catchments in the water system of the Körös rivers. Since the construction of the Eastern Main Canal, the variation in the water levels has lost its natural character.

The Hortobágy-Berettyó. This flows in the north-western part of the south-east Hungarian Plain. Originally, under the name of the Hortobágy, it was a tributary of the Berettyó. Its water was collected from the periodic groundwaters of the plain of the Hortobágy and from the flood-waters of the Tisza. It was sealed off from the Tisza flood-waters in 1830, and therefore its northern bed dried up. In the framework of the present water management, a welcome expansion of the irrigation possibilities has been continuing in this area (Eastern Main Canal) since 1954.

In addition to the above-mentioned surface water courses, the interlaced, entangled bed-systems of numerous *stream and brook networks* are to be found in the area of the county. With the prevention of the flooding, however, the earlier hydrogeographical conditions of every stream, brook, rivulet, etc. altered substantially. For example, with the canalization of the region the stream and brook systems became so enmeshed that it is nowadays not possible to speak of independent water-catchment systems. In the times before the flood-water regulation, the brooks and streams possessed larger water reserves, and caused many flooding catastrophes. For purposes of elimination of floods and inland waters, the ancient water courses were canalized, and their old natural states can be perceived only in certain sections. In the parts still remaining in their natural states, inland-water reservoirs have generally been established. For example, in the system of the Körös rivers inland-water reservoirs can be observed in the line of the Szarvas dead branch, the Dögösi, Kákafoki, Cigány-ér, the Határ-ér, the Köles-Ér, the dead Fast Körös, the Élővíz channel and the Gyepes-ér, as well ast the Kórógy, the Veker, the Kurca and the Száraz-ér. The irrigation-complex system of the Körös rivers has developed in the environment of the main rivers. Only an insignificant percentage of the dug channels, however, can be employed for irrigation or for leading off inland waters. The necessity of irrigation is beyond doubt, but the fluctuating water reserves of the Körös rivers frequently cause problems from the aspect of the water supply. The only solution at present seems to be the construction of storage sluices and reservoirs. In the 1960-s it was possible to irrigate approximately 48 000 kh, of which about 22 000 kh were in fact irrigated. Besides the extreme water levels, another factor significantly influencing the solution of problem-free irrigation is the suction effect of the channels. A water loss of some 10—15% may be reckoned with. In addition, there is a very marked degree of alluvium deposition in certain irrigation channels.

The stream and brook systems are generally connected to the main rivers by artificial means. Since the embankment system created in the regulation largely eliminated; the gravitational run-off of the brooks and streams, the running-off inland waters are connected with the living rivers only via sluice or pumping systems. For certain of the larger water courses, such as the dead Fast Körös, the Száraz-ér, the Gyepes-ér, etc., a protective embankment system had to be prepared for flood-defence purposes.

Regulation of the inland waters of the area still leaves much to be desired at present. For example, in the case of normal inland-water levels, with average precipitation distribution, inland waters are still observed for periods longer than 20 days. Protracted inland water means considerable water-damage as regards agricultural production. Particularly the spring inland waters lead to severe damage, since these inland waters most frequently coincide with the high-water levels of the main rivers (e.g. the years 1881, 1888, 1895, 1910, 1916, 1917, 1920, 1932, 1940, 1942, 1953, 1956, 1967 and 1970). In order to eliminate the occurrence of these surface inundations, which can by no means be characterized by any periodicity, the further building of sluice and pumping systems is necessary, the further up-to-date construction of channels must be carried out, and the present run-off rate of the area must be increased. The density of the network of water courses and channel systems in the area of the county is changing in a varying manner. The concentration of channels is generally higher in the deeper-lying areas, since the low terrain situation and the impermeable nature of the surface layer stronngly justify this. In spite of the high channel density, however, there are still prolonged inland waters even here. In general, the specific water-network density of the terrain in the inland-water system of the Körös rivers is 1—1,5 km/km^2, while the specific water transport varies approximately in the range 20—30 l/sec. In contrast, the specific water-network density of the higher table-land parts is only 0—1,0 km/km^2, and the specific water transport is 0—20 l/sec. On the loess table-land north-east of Orosháza there is even an area which stands apart from the present inland-water system, i.e. the surface is not connected to any of the inland-water systems.

It has been mentioned previously that the density of the water network is closely correlated with the compositions of the surface and the near-surface deposits. In general, the water network is comparatively dense on the surface of a weakly-permeable or impermeable deposit, and at the same time rarer on permeable, more porous surfaces.

The distribution of the precipitation in space and time and its quantitative course can have a considerable influence on the water levels of the rivers and on the variations in their water reserves. The rivers of the county are characterized by extensive water fluctuations, and by the irregularity of the changes in the water fluctuation. This phenomenon is connected with the capricious behaviour of the precipitation in the immediate and the more distant environment. The Erdélyi-Sziget Hills rising on the rim of the Plain have an important role in the almost 22 000 km^2 water-catchment system of the Körös rivers. The water reserves of the water courses originating in the hilly and foothill forelands vary in accordance with how the precipitation conditions develop in the individual water-catchment systems. The more important water-providing areas affecting the county: the region of the Ér (90 m above sea-level), the Réz Hills (700 m), the Király Forest, the Bihar Hills (1800 m) and their western slopes. Since the main valleys of the hilly regions open in the run-off directions of the rivers, the rivers generally run west-east. In the open valley structure straight and high-fall river-valleys have formed, which rapidly carry an appreciable mass of water down onto the Plain. As a consequence of the fast run-off, the levels of the rivers vary rapidly in response to precipitation (1966 and 1970 floods).

Taking into account the annual totals of the precipitation for the water-catchment areas, the precipitation amount is already double in the higher belts of the hilly regions, i.e. the hilly regions contribute more significantly to the water turnover of the rivers. Since the amount of precipitation falling on the water-catchment area generally reflects a precipitation distribution that can be linked to certain periods and not to a definite season, the periods of flooding of the rivers do not display a close connection with the seasonal rhythm either. In general, the high water-levels of the rivers in spring are due to the snow reserves accumulating during the winter, and not to the amount of precipitation falling directly. For instance, if the melting in the hilly region proceeds quickly, the suddenly-produced appreciable quantity of water will strongly increase the reserves of the river water. Rapid thawing may sometimes be accompanied by catastrophic flooding (e.g. 1872, 1874, 1919, 1925, 1932 and 1966). Particularly noteworthy flooding was caused by the rapid snow melting in 1966. The early thaw (Feb. 7) occurred as a result of warm rain (25—35 mm) falling on the hilly region. The flood-water level of the enormous masses of water rushing down rose above the defence-embankment on the Berettyó even on Feb. 9, broke through the left-hand embankment opposite Szeghalom, and inundated an area of 6000 kh. The embankment similarly burst on the White Körös on Feb. 11 at Kisjenő in Romania. This bursting led to the total inundation of the two regions between the Körös rivers, an area of about 13 000 kh. If the melting takes place over a longer time, however, then the slow and gradual water replacement does not give rise to flood danger. The flooding of the rivers in early summer is rather a consequence of a period of heavier precipitation (e.g. in 1970). In the knowledge of the annual precipitation of the water-catchments, the occurrence of early-summer flooding can usually be taken as certain. In this case the amount of water in the rivers decreases considerably as a consequence of evaporation, and therefore at times of early-summer flooding the average water reserves of the rivers are generally less than when the spring melt-waters flow down. Autumn floodings also occur on the rivers, but the probability of these are minimal and they are also insignificant as regards the quantity of water.

Apart from the precipitation factors, the temperature too plays an important role in the lives of the rivers. The water-temperatures of the larger rivers usually follow a well-developed annual course. The fluctuations of the water-temperatures of these rivers are by no means as extreme as on the dry surfaces of the district. The 24-hr daily fluctuation too can normally be observed only on the occasion of low-water. At times of extreme weather it may occur that the daily fluctuation of the water-temperature is 3—4 °C, or exceptionally 5—6 °C. The monthly temperature changes are generally reflected in the water-temperatures of the rivers. More extensive temperature changes in the lives of these river waters occur particularly in the autumn months. Freezing of the rivers can not be observed in every year, nor in the case of every river. On the basis of many years' experience (1920—1950), the frequency with which total freezing-over of the Double Körös did not take place was about 6—15%. This can not be said of the Triple Körös or the Fast Körös, where freezing-over can be taken as occurring with 100% frequency in every year. The average time for the appearance of ice on all of the rivers of the county is the middle of December. Extreme cases also occur, however, when the ice appears even at the end of October. The general freezing-over of the rivers occurs at the end of December, and has an average duration of 40 days. In the winters of the colder years the duration of freezing-over may attain even 90—100 days. The period of ice-melting on these rivers is characteristically the second half of February. At such time the ice disappears from every river, but in extreme cases the ice may melt only at the end of March and the beginning of April. As regards the thawing and the running-down of the melt-waters, the rivers are generally situated in a favourable position. However, it can occur that melting takes place earlier on the western-exposed slopes of the Erdélyi-Sziget Hills than on the deeper-lying terrain of the Plain. In this case the region between the Körös rivers is threatened by the danger of flooding.

From the aspect of everyday life, the nature and quality of the river waters is becoming a question of increasing importance. We cannot speak of extensive artificial water pollution in the area. In the future too, in the course of transformation of the landscape, the establishment of industrial settlements, urbanization, etc., it is necessary to find those protection solutions which inhibit the contamination of the natural water reserves of the rivers. According to the data of the overall plan for water management, the water concentration of the rivers of the area is less than 500 mg/l in virtually every section of the rivers of the area; with a slight deviation, the most concentrated is the Fast Körös, with a value of 500—600 mg/l. From the aspect of irrigation too the quality of the waters is perfectly acceptable. In the future too we must strive for the purity of our waters.

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