

## DEPENDENCY OF CARTOGRAPHICAL VIEW OF THE HYDROGRAPHICAL NETWORK IN LITHUANIAN UPON THE TOPOGRAPHY

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The view of Lithuanian rivers network on a map is closely connected topographical characteristics of the country, that were influenced by the development of land surface under Pleistocene glacial period exaration and accumulation.

### **Situation of rivers in the respect of relief and the configuration of catchments**

There are not many of our rivers that flow according to the direction (displacement) of lowlands and highlands. Almost all big rivers do not care these directions and flow down across or slantwise to inclination, sometimes, they even flow against the surface inclination. For example, river Minija, that comes down the Žemaičių highland and is not flowing straight to the Baltic sea according to Pajūrio lowland inclination, but turns Southwest, going almost perpendicularly to the inclination of lowland. Only Salantas is of the same flow direction among the tributaries. All of the rest tributaries of Minija flow down the inclination of the Western Slope of Žemaičių highland, some of them turn to the Southwest, other turn to the Northwest. The catchment of Minija river is very asymmetric. One more river in the Pajūrio lowland Akmena-Dangė that flows parallelly with Minijas has the analogous situation. All rivers of the Pajūrio lowland, that flow perpendicularly to lowland's inclination (rivers of Minija, Salantas, Erla, Akmena-Dangė, Tenžė, partly Šventoji) use the old valleys, that were formed by

the ice melting water. These old valleys were hollowed out by the fluvio-glacial streams that flowed along the glacier edge to the South and it shows the gradual withdrawal of glacier from the Žemaičių highland to the side of Baltic hollow. The other rivers of Pajūrio lowland and the Western Žemaičių highland's slope flow down their own valleys. They were formed later by flowing down precipitation water and were formed to follow the existing surface inclinations.

The river Jūra is in the analogous geomorphological situation. It crosses the surface inclination slantwise and has very asymmetrical catchment. This situation of Jūra reflects hydrological conditions that were dominant at the melting ice water, flowing along the glacier edge to the South, to the big preglacial lake situated in the region of Tauragė, Jurbarkas and Šakių towns.

While withdrawing West from the Žemaičių highland, the edge of glacier stopped here and created a clear moraine mountain ridge (the mountain ridge of Vilkiškės). The left tributaries of the Jūra river were started from the fluvio-glacial streams, that flowed from the Middle lowland to the preglacial lake, that was already mentioned. When the water vanished from this lake, the river Jūra and its tributaries continued their channel through the lake bottom.

The river Mituva is in the same situation as the left side tributaries of the Jūra river. Its flow goes with the surface inclination. Its sudden turn in the lower reaches of the river appeared when the water from the preglacial lake flowed out continuing the river stream in the lowest place of the lake bottom.

Stream of the Dubysa river do not go with surface inclination. These features Dubysa has inherited from the icing period. The edge of glacier had stopped for some time along the right bank of the Dubysa river, while it was withdrawing to the side of Middle lowland. But this river started a little bit later, when the glacier edge already withdrew to the edge moraine line of Šiauliai-Radviliškis. (Fig. 1). Then the distal stream of glacier waters was forced to flow along the edge moraine, left by the earlier glacier stop line.

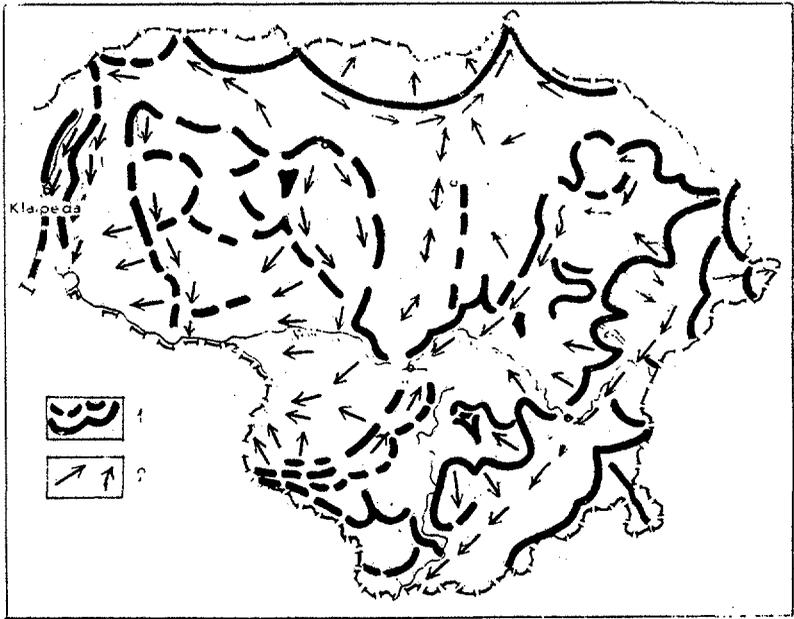


Fig. 1. End moraine ridges and the direction of river flows in Lithuania (A. Gaigalas, V. Dvareckas, 1994)

The Nevėžis river does not follow the inclinations of Middle lowland. It flows to the South, while the Middle lowland has inclination to the North. The old valleys of Nevėžis river were created, by the distal streams, flowing from the glacier edge to the South by the direction of Middle lowland inclination (joining) connecting. Later on the elevation of land surface imported for the Middle lowland the North side inclination, but did not manage to change the Nevėžis river direction, only created possibility for the Mūša river to catch some of Nevėžis tributaries. Other tributaries of the Nevėžis river appeared later on, when precipitation waters flowed down and were forced to go with the changed inclination. The elevation of land surface, that turned one part of Nevėžis tributaries to the Mūša river, the right side tributaries of the Šventoji river were turned to the side of Nevėžis.

The Nevėžis river flows in the centre of Middle lowland and that's why it has quite catchment (43% of the catchment area are on the right side and 57% on the left side).

Situation of the Šventoji river is analogous to the one of Minija. It flows down the Aukštaičių highland and suddenly turns the Southwest and flows at the foot of these highlands also showing the situation of glacier edge at some period. Asymmetric view of Šventoji catchment was determined by its cross situation in respect with surface inclination.

The big tributary of the Neris river is the Žeimena river, that flows in the centre of Southeast plain by its inclination and get tributaries from the both sides: from the Aukštaičių highlands and from Švenčionių highland. The left tributaries of the Žeimena river are shorter than their right ones, because watershed crest of the later highland is not far from this river, so it created asymmetrical catchment.

The biggest river of Southeast Lithuania is Merkys, that flows down the inclination of plain. It has big tributaries from the both sides.

The biggest river of the Užnemunė plain is Šešupė that flows down by the inclination of this plain. It created a symmetrical catchment.

The eldest river of Lithuania Nemunas in this countries territory do not care about an inclination of surface. This river crosses the Southeast plain, it break through the highlands abounding in lakes and then, as if ignoring the lower places of Middle lowland chooses its way through the highest part of this lowland in the section of Kaunas-Seredžius (1st example).

The Northern Lithuanian rivers follow the directions of inclination, but there are asymmetric catchment among them too. The Mūša river has the most asymmetric catchment, that flows at the Southern foot of the Northern Lithuania edge moraine mountain ridge, cross the Middle lowland inclination and it can not take the bigger tributaries from the left side.

From this review we can notice, that all Lithuanian rivers can be divided into three main groups, according to the relation between the flows and the orographical inclinations of surface. The first group contains rivers, that flows by the surface inclination. These rivers are called consecutive. The second group consists the rivers, flowing cross or slantwise to the surface inclination, these are non-consecutive rivers. The third group contains these rivers, that flows against surface inclination, they are called reversed rivers. The first and third group rivers have symmetric and the second group has asymmetric catchments. The degree of symmetry for the biggest Lithuanian rivers Neris and Nemunas in some parts is different [1-4].

### 1. The Features of Hydrological Regime (characteristic)

Lithuanian area being in the zone of an increased humidity and at the margin of the Last Scandinavian Glaciation is notable for a dense and a very complicated hydrographic network. A view of this network is seen already in the maps of the 2nd century A.D. Later this view was being continually specified together with development of cartography and hydrology.

Regular regime observations of river runoff in Lithuania started from 1812 in the lower courses of the Nemunas river at Smalininkai. Average density of the river network, including artificial water courses, is given in the modern maps. It equals to 0.99 km/km<sup>2</sup>. Lithuania's Central Plain covered with morainic loam has the river network density reaching to 1.45 km/km<sup>2</sup>, whereas this density in South East Sand Plain, where precipitation easily soaks into the subsoil, is lower - 0.45 km/km<sup>2</sup> in average. There are 816 rivers with their length exceeding 10 km, and only 19 rivers are longer than 100 km .

About 71.5 percent of the Lithuanian areas is in the Nemunas catchment. Only northern parts of Lithuania belong to the catchment. Only northern parts of Lithuania belong to the catchment of the Mūša-Nemunėlis (13.4% of the total

area of Lithuania), Venta (8%), Daugava (2.4%) and smaller rivers - such as Bartuva, Sventoji and others (4.1%).

One can see in the map that the catchment area of the Nemunas River is rather asymmetric. Clearly expressed water divides in the relief are met only in the upland areas or those with morainic ridges making partitions for the lowlands. There are many flat bogged water divides shown in the map.

Longitudinal profiles of Lithuanian rivers differ greatly. Therefore, they can be divided into two groups and each group into 7 types. The authors present morphotypological and geomorphological analyses of longitudinal profiles, as well as their indexation and classification.

The shapes of longitudinal profiles are distributed according to a certain law. This is confirmed by a mathematical statistics. Longitudinal profiles of Lithuanian rivers are related to development of glacial relief and elements of deep structures. The authors applied new cartographic methodology.

River profiles coincide rather well with the zones of tectonic fractures and boundaries of tectonic structures ( blocs) and lineaments seen in the space photographs. These structures are given in the maps.

About 32 percents of precipitation in Lithuania flow down the rivers into the sea. A runoff modulus ranges from 5.1 to 12 l/s/km<sup>2</sup> . The following maps have been compiled: river water content, average annual runoff, average seasonal (spring and summer, fall and winter) runoff and average debit maps.

Lithuanian rivers are fed with water in different ways. Snow meltwater in the average annual runoff of Nemunas makes up 40%, rainwater 25% and groundwater about 35%. The rivers are usually frozen for three months: from early December till late march. Annually rivers transport about 0.5 million tons sand drift and suspended matter.

Lithuanian rivers can be attributed to those with water of moderate turbidity (25-50 g/m<sup>3</sup>) and of moderate mineralization (200-300 mg/l). The National Atlas comprises maps of water mineralization and chemical

composition, pollution and hydrological awareness, hydrological regionalization and water resources, as well as their utilization [5]. Cartographic portrayal of hydrographic network is shown in 22 pages of a new national atlas published in 1981.

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