prises the eastern part of the Wielkopolska and Mazowiecka Lowlands, and according to Romer's (1949) classification it belongs to the climatic region called the Land of Great Valleys. Precipitation there is the lowest in Poland, below 500 mm/year. The growing season lasts from 200 to 220 days a year.

The Płock Basin is situated at the boundary between two major ethnic-cultural regions. The western part belongs to Kujawy, and the eastern to Mazowsze. Because of the scattered layout of settlements and the dense vegetation cover, this boundary is not very pronounced. Large differences are apparent in rural and agricultural management.

Kondracki (1994) in his physico-geographical division of Poland (in decimal system) assigns the Płock Basin to the mezoregion no. 315.36, being a part of the Toruń-Eberswalde Pradolina Macroregion.

In the Płock Basin the sandy terraces have dunes overgrown with forest, and numerous meltwater depressions are commonly filled with water. The lakes form a unique landscape-floristic assemblage called the Gostynińskie Lake District. In order to protect this landscape the Gostynin-Włocławek Landscape Park was established in 1979. The Park comprises 14,195 ha. Cities of Płock, Włocławek, and Gostynin are at the margin of the basin. Lake Gościąż is located in the area of the Landscape Park, 18 km SSW of Włocławek and 4 km S of the Włocławek Reservoir. The lake area is now 41.7 ha, and it is drained by the Ruda River, which discharges to the Włocławek Reservoir near Dobiegniewo.

Lake Gościąż and other lakes in the Płock Basin are located at an elevation of only 60–70 m a.s.l. Groundwaters draining the Kujawy Upland bring a permanent supply of water to the lakes and thus ensure small oscillations of water table, regularity of seasonal changes in water temperature, and continuous sedimentation during the entire period of the lake existence. Therefore laminated sediments filling the basin of Lake Gościąż can also occur in other deep lakes of the Gostynińskie Lake District. The position of Lake Gościąż with respect to the water table of the Włocławek Reservoir and the Vistula is presented in Fig. 2.2.

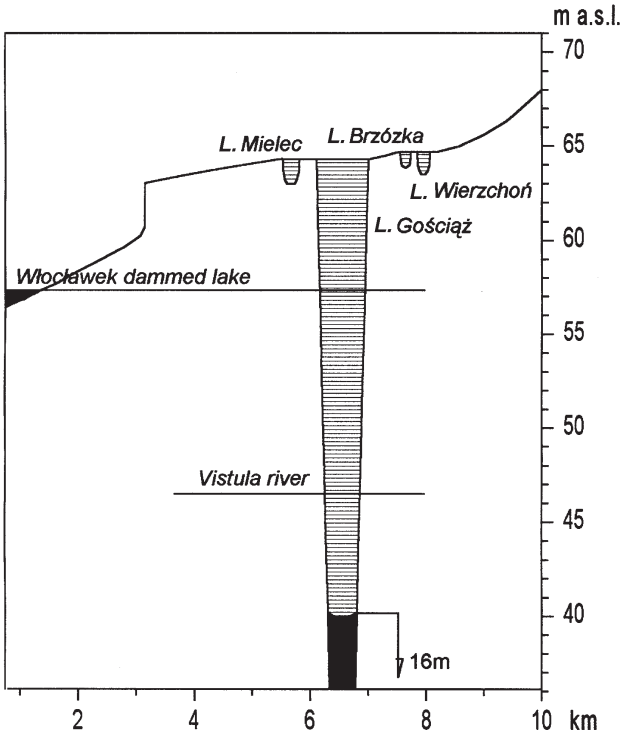


Fig. 2.2. Location of Lake Gościąż and adjacent lakes with respect to the levels of the Vistula River and Włocławek Reservoir (after Glazik 1978).

2.2. THE GEOLOGICAL STRUCTURE OF THE LAKE GOŚCIĄŻ REGION

Teresa Madeyska

The geological structure of the Płock Basin has been studied by Lencewicz (1927, 1929), Baraniecka (1979), Baraniecka et al. (1978), Baraniecka and Skompski (1978), Skompski (1968, 1969, 1971) and Mojski (1960). The geomorphological evolution of the Vistula Valley between the Warsaw and Toruń Basins was studied by Wiśniewski (1976, 1982, 1987, 1990), Starkel (1990) and others. Close examination of several boreholes in the Płock Basin has increased knowledge of these deposits.

The thickness of Quaternary sediments in the Płock Basin is low because of its situation on the Quaternary basement elevation called "the Płock Elevation" and attributed to deformation of the plastic Tertiary deposits by the oldest (Podlasie) ice-sheet as well as by younger ice-sheets (Lamparski 1983). Such activity has made deep depressions (e.g. Mochowo Depression situated NE of the Płock Basin) and high elevations, with relief reaching 200 m. The Płock Elevation includes the Płock Basin and a strip of the morainic plateau more than 10 km wide, NE from the Vistula Valley. In the earlier part of the Quaternary a thick series of glacial and interglacial deposits accumulated in the depressions, while denudation prevailed in the elevation zones; as a result, the surface became less uneven. The ice-sheet of the Last (Vistulian) Glaciation covered an already smoothed surface, with the depressions filled up to the level of the elevations. At the site of the present Płock Basin, the result was the emergence of a new depression, conducive to the accumulation of Last Glaciation deposits (Kopczyńska-Lamparska & Piwocka 1981).

Skompski (1969) thought that the glacitectonic activity influenced the formation of the Płock Basin in another way. He maintained that the older South Polish ice-sheet from the NE formed the Płock Basin depression and provoked the uplift of clays along the northern and southern edges of the Basin. Glacial deposits from that period

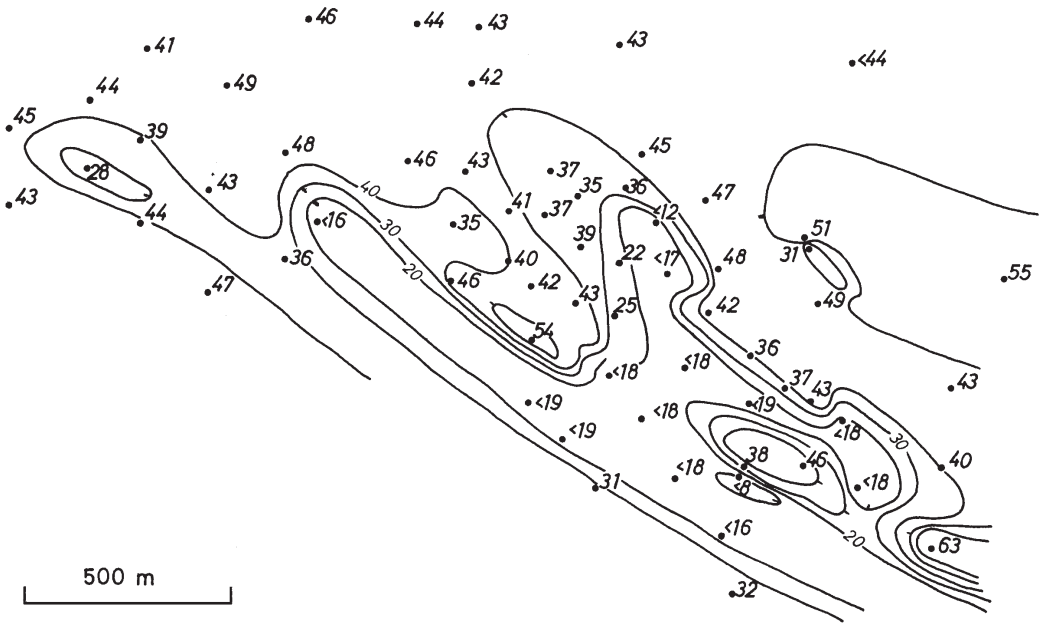


Fig. 2.3. Relief of the top surface of Tertiary deposits in the area situated in a distance of 1 km to NE from Lake Gościąż (for location see Fig. 2.4). Contour lines in metres a.s.l. are based on data from boreholes made for economic reasons (Narwojsz & Pruszkowski 1987).

were removed from the Basin during the Great Interglacial (between the South Polish and the Middle Polish Glaciations) period. The Middle Polish Glaciation deposits, connected with ice-sheet transgression from the NW, were eroded in the Eemian Interglacial, and in the western part of the Płock Basin they were so completely removed that the Last Glaciation deposits lie directly on the Tertiary basement.

The old Quaternary tectonic movements probably influenced the relief of the surface of the Tertiary formation

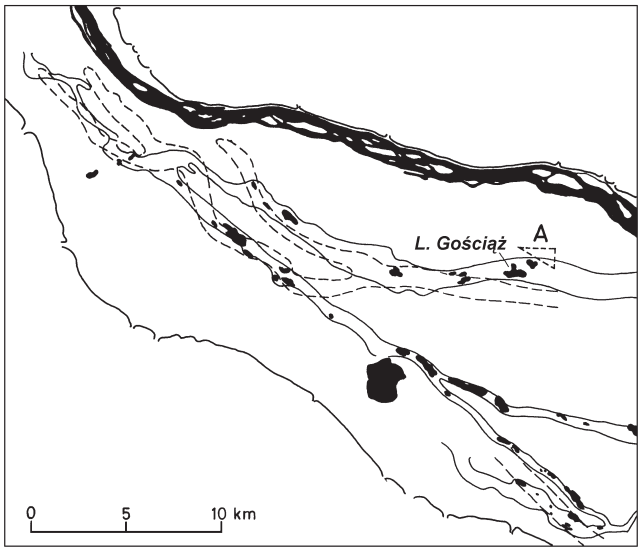


Fig. 2.4. Two generations of subglacial channels (after Kopczyńska-Lamparska & Piwocka 1981). The older generation of fossil channels is shown by dashed lines, the younger one, partly preserved on the present ground surface is shown by continuous lines. A – location of Fig. 2.3.

(Baraniecka 1975a, b), however, it is difficult to define precisely their role in the area.

The basement of the Quaternary sediments in the Płock Basin is composed mainly of Pliocene and Miocene clays (Poznań Formation), silts, sands, and brown coals. Cretaceous limestones are recorded only locally. The top of the Tertiary sediments is uneven (Fig. 2.3) because of erosional, evorsional, and exarational processes as well as various glacitectonic disturbances, especially well exposed in the right bank of the Vistula River between Płock and Włocławek before construction of the Włocławek dam, where the differences in level exceed 130 m (Ber 1960, Jaroszewski 1963, Łyczewska 1964, Brykczyński 1982).

Folds and overthrusts were formed by the ice-sheet coming from the NE (Jaroszewski 1963) in the older stage of the Middle Polish Glaciation (Skompski 1969) or by pressure perpendicular to the movement of the Podlasie Glaciation ice-sheet (Lamparski 1983). It results in a large differentiation of thickness of the clays and locally in shearing.

Kopczyńska-Lamparska & Piwocka (1981) distinguish two generations of subglacial channels (Fig. 2.4), orientated NW-SE and WNW-ESE, originated during the Leszno and Poznań phases of the Vistulian Glaciation. Sierżęga and Narwojsz (1988) describe a long valley 50 m deep extending westwards along the southern side of Lake Gościąż. This valley in the western part of the Płock Basin completely dissected the Tertiary deposits and cut into the Cretaceous deposits. In the borehole situated 1 km south of Lake Gościąż it was found, that this valley is filled in its lower part with a layer of gravels and

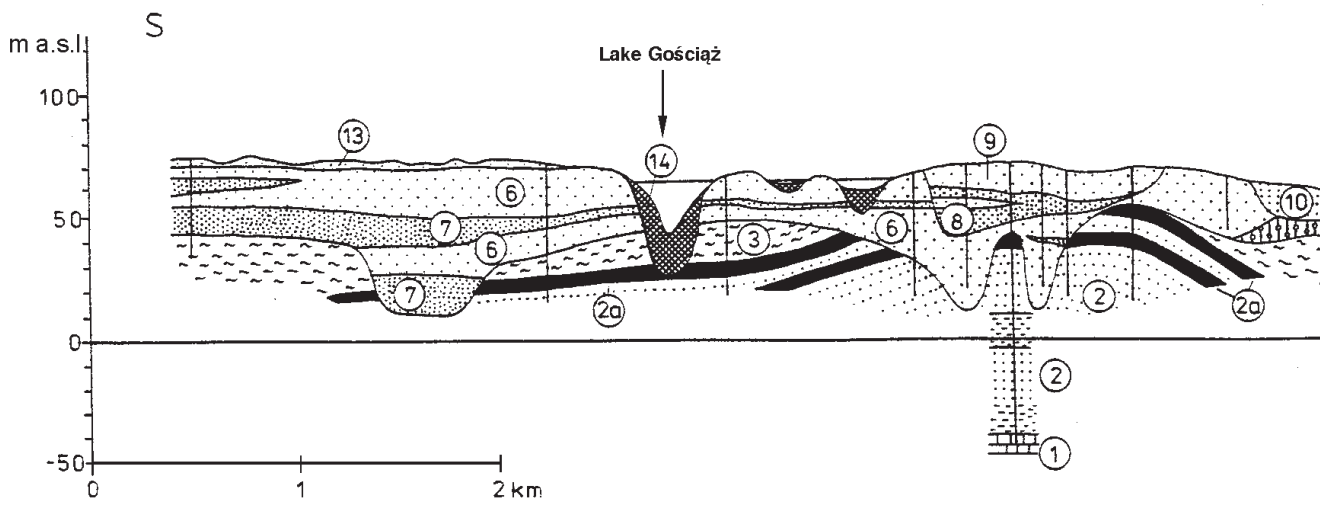


Fig. 2.5. Geological profile of the central part of the Płock Basin (after Madeyska 1991). Cretaceous: 1 – chalk; Miocene and Pliocene: 2 – clays, silts and sands, 2a – brown coal, 3 – clays with siderite concretions and gypsum (Poznań Formation); Middle Polish Glaciation: 4 – glaciofluvial sands of the morainic plateau, 5 – boulder clay; Vistula Glaciation, Leszno phase: 6 – fine, medium and coarse grained, glaciofluvial and glaciolimnic sands, 7 – glaciofluvial gravels and coarse sands; Poznań phase: 8 – fine, medium and coarse grained, glaciofluvial and gla-

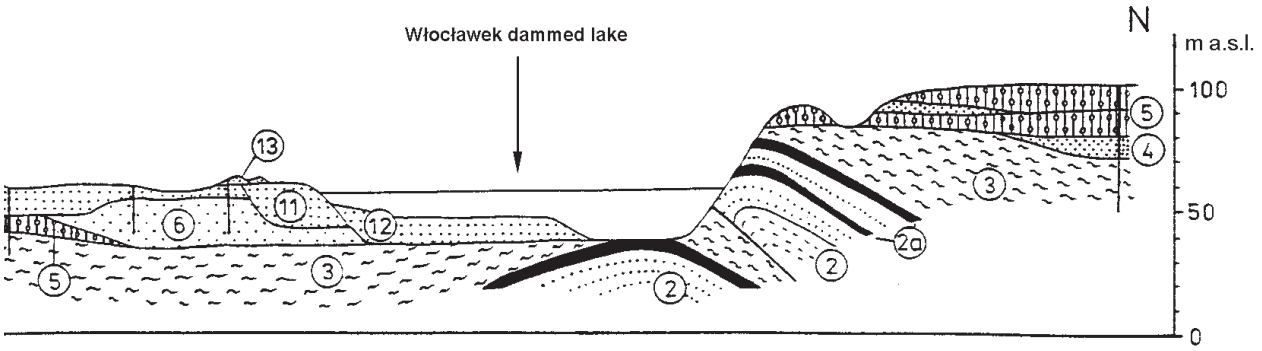
sands several meters thick containing many fragments of brown coal. This indicates that the valley sides built of Tertiary deposits were washed away.

Pleistocene sediments in the Płock Basin mainly represent the Last Glaciation (Fig. 2.5). Tills and glaciofluvial deposits from the older glaciations as well as interglacial deposits appear on the morainic plateau area and – in the Basin – only as thin discontinuous patches (Skompski 1969, Kopczyńska-Lamparska & Piwocka 1981), resulting from their initial low thickness and several periods of intensive erosion. These authors emphasize difficulties concerning univocal stratigraphic attribution of these deposits because of a lack of stratigraphic indicators.

Frontal and ground moraines as well as kames and eskers of so-called Ciechomice level (90–92 m a.s.l. – Wiśniewski 1987) east of the Skrwa River originated in the Last Glaciation period (Figs 2.6, 2.7). In the remaining area of the Basin, sands, gravels, and silts prevail, while till is rather insignificant. Their stratigraphic determination is based on the sequence of accumulation and erosion processes. According to Kopczyńska-Lamparska, during the ice-sheet transgression fine sands and silts were deposited on the erosive bottom of a big ice-dammed lake with low water flow, forming the level 80–82 m a.s.l. During the maximum Leszno phase the subglacial channels were formed and later filled with sands, gravels, and boulders and covered with two horizons of till, preserved only in the western part of the Płock Basin. The erosion preceding the Poznań phase was followed by accumulation of glaciofluvial and ice-dammed lake sediments. After this the second generation of subglacial channels formed, partially visible on the present ground surface (Fig. 2.4). Deposition of the glaciofluvial sediments repeated at the end of the Poznań phase and during the period preceding the Pomeranian phase. These sediments cover a major part of the Płock Basin (Fig. 2.6). Lencewicz (1927) distinguished them as terrace III, while Kopczyńska-Lamparska named them "the fluvioglacial horizon". In the eastern part of the Basin, Skompski (1969) divided them into six glaciofluvial horizons and correlated them with the Pomeranian phase. In the western part of the Basin not far from the Vistula River gorge near Włocławek, Wiśniewski (1976) separated four terraces, with their continuation in the gorge. He found that waters flowed out to the east. The geomorphological units distinguished by Skompski and Wiśniewski are at almost the same level, and only locally is it possible to distinguish the edges separating them. The relief and the geological structure of the Basin could not be the basis of dividing the glaciofluvial horizons into separate chronological units (Kopczyńska-Lamparska & Piwocka 1981). New borehole analysis favours this idea. The surface of the glaciofluvial horizons ranges from 62 to 77 m a.s.l.; the depressions left by dead ice blocks, numerous lakes with differentiated depth, and remnants of subglacial channels are present on it (Skompski 1969).

The first and oldest river terrace III, 60–65 m a.s.l. (Fig. 2.7, Madeyska 1993), which extends along the whole Vistula Valley in the Płock Basin and continues in the gorge, originated during the Pomeranian phase. At that time, the first free water outflow to the North opened (Kopczyńska-Lamparska & Piwocka 1981). Terrace III is built up of sands and gravels, with mud inserts in the upper part; their thickness reaches 15 m.

In the eastern part of the Płock Basin three Late-Glacial terrace surfaces were distinguished by Florek et al. (1987). The oldest one (TP-0) is preserved only in a small fragment in the northern part of the Vistula River valley. The end of accumulation of the fluvial deposits



ciolimnic sands, 9 – glaciofluvial gravels and coarse sands; Pomeranian phase: 10 – river sands of the Vistula River terrace III; Late Glacial and Holocene: 11 – sands of the Vistula River terrace II, 12 – sands of the Vistula River terrace I (under the water level at present), 13 – dune sands, 14 – lake sediments.

forming the middle terrace level (TP-1 – 69–62 m a.s.l.) was determined by ^{14}C dating of organic material filling the abandoned river channels as 11,900±500 and 14,390±160 yr ^{14}C BP. On the basis of the second date, as well as the height of this level, this terrace could be correlated with the terrace III developed in the main part of the Płock Basin. The lowest (TP-2 – 63–59 m a.s.l.) terrace surface is separated from the previous one by a scarp 4–5 m high. The fluvial accumulation on it terminated at the turn of the Late-Glacial and the Holocene

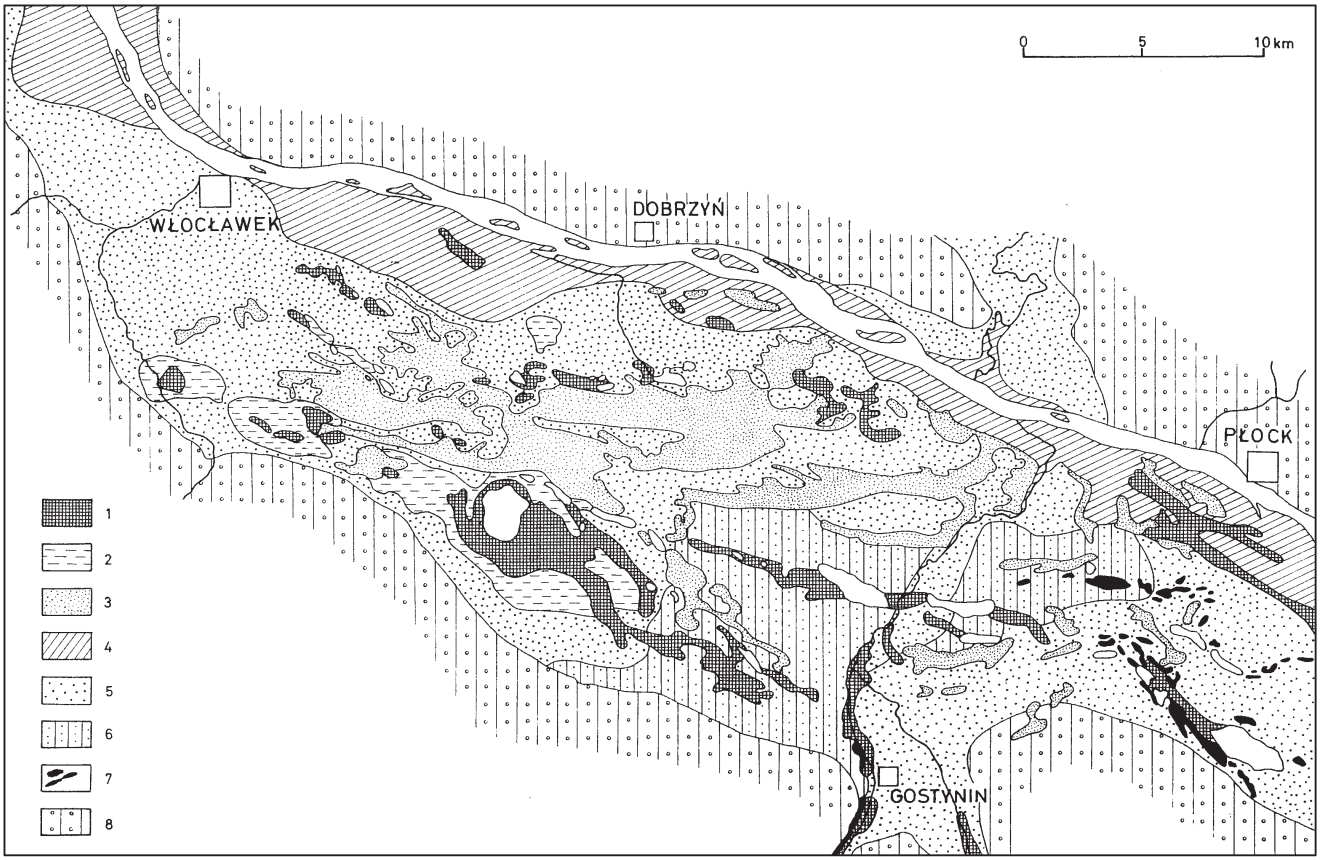


Fig. 2.6. Geological map of the Płock Basin (compiled from various data: Baraniecka & Skompski 1978, Kopczyńska-Lamparska & Piwocka 1981, Skompski 1968, 1969, 1971, Starkel (ed.) 1990). 1 – peat, 2 – lacustrine sands and silts, 3 – eolian sands, 4 – fluvial sands, gravels, and muds, 5 – glaciofluvial sands and gravels, 6 – glaciolimnic sands and silts, 7 – boulders, gravels and sands of eskers and kames, 8 – till and glaciofluvial gravels on the morainic plateau. Vistula River before the Włocławek dam construction is shown.

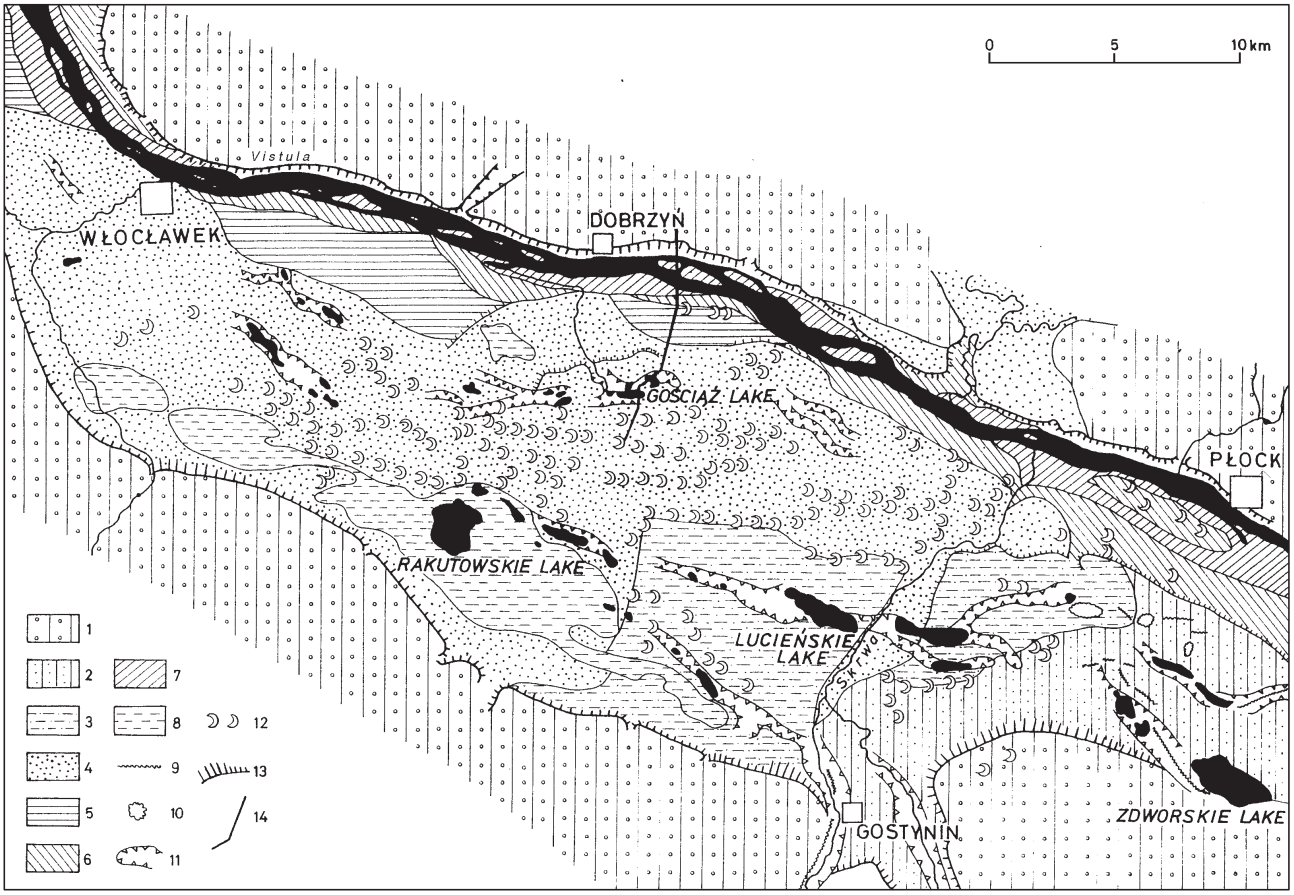


Fig. 2.7. Geomorphological map of the Płock Basin (compiled from: Baraniecka & Skompski 1978, Kopczyńska-Lamparska & Piwocka 1981, Skompski 1968, 1969, 1971, Starkel 1990, Wiśniewski 1976, 1987). 1 – morainic plateau, 2 – Ciechomice level originated due to deglaciation processes, 3 – glaciolimnic and glaciofluvial level 80–82 m a.s.l., 4 – glaciofluvial levels 62–77 m a.s.l., 5 – fluvial terrace III dated to the end of the Pomeranian phase, 6 – Late-Glacial fluvial terrace II, 7 – Holocene flood-plain (terrace I), 8 – lacustrine and swampy plains, 9 – eskers, 10 – kames, 11 – glacial channels, 12 – dunes, 13 – erosional edges, 14 – profile – see Fig. 2.5. Vistula river before the Włocławek dam construction is shown.

(9,620±300 ^{14}C BP – Florek et al. 1987). It corresponds to the terrace II (56–62 m a.s.l. – Starkel 1990) in the main part of the Płock Basin, previously described by Skompski (1961, 1969) as the Late-Glacial one. The end of the river sedimentation was documented also by the Preboreal age of the organic deposits covering the fluvial ones (Borówko-Dłużakowa 1961).

Holocene flood-plain (terrace I – 50–59 m a.s.l.), like the older two, is composed of sands with gravels in the lower part and muds in the upper part, with a total thickness up to 10 m. At present, following the Włocławek dam construction, terrace I has been inundated by the artificial lake waters.

2.3. PRESENT-DAY CLIMATIC CONDITIONS OF THE LAKE GOŚCIĄŻ REGION

Gabriel Wójcik & Rajmund Przybylak

Lake Gościąż lies in the centre of the forested Płock Basin at the height of 64.3 m a.s.l. and about 20 km SSE from Włocławek. The lake is surrounded by a forest that stretches in a close belt 10–15 km wide and about 55 km long along the left bank of Vistula River from Płock on the SE to Lubań on the NW. Climatically, this region belongs to the Land of Great Valleys (according to Romer 1949) and to the VII or central province in the agro-climatic classification of Gumiński (1948).

The present-day climatic conditions of the Gościąż region are discussed on the basis of data from nearby stations. The nearest station with all the needed basic meteorological elements is in Płock. Data from this station for the period 1951–1989 have been used for the description of temperature and precipitation. Directions and velocity of wind have been analysed with data from the decade 1951–1960 (Atlas Klimatyczny Polski 1971). Tables 2.1 and 2.4 contain mean (m) as well as the lowest (Nm) and the highest (Nw) values for long periods. The last two characteristics describe the range of changes of air temperature and precipitation at Płock over the period 1951–1989. The spatial distribution of precipitation of the lake area and its state in recent years (1981–1989) is described on the basis of data from Baruchowo, Brześć Kujawski, Duninów, Olganowo, Płock, and Włocławek.