EKOLOGIA POLSKA (Ekol. pol.)	41	1–2	7–26	1993

Elżbieta BAJKIEWICZ-GRABOWSKA

Department of Hydrology, Warsaw University, Krakowskie Przedmieście 30,
00–927 Warsaw, Poland

PHYSIOGEOGRAPHICAL AND HYDROGRAPHICAL CHARACTERISTICS OF SUWAŁKI LANDSCAPE PARK (NORTH-EASTERN POLAND)

ABSTRACT: A brief description of main relief forms, climatic conditions and river network of Suwałki Landscape Park. The development of river-lake systems (Szeszupa, Szelmentka, Czarna Hańcza) is characterized, morphometric characters of lakes in each system are given.

KEY WORDS: relief, river-lake network, lakes, Suwałki Lakeland.

1. PHYSICO-GEOGRAPHICAL ENVIRONMENT OF THE AREA

Suwałki Landscape Park (SLP) in north-eastern Poland is in the Lithuanian Lakeland in mesoregion of East-Suwałki Lakeland (Kondracki 1988). A considerable part of the Park is in the Jeleniowo Upland microregion, and only its northwestern part belongs to the Wiżajny microregion (Richling 1985). The morphology of SLP and of the whole Lithuanian Lakeland is genetically connected with accumulative and erosive effect of the glacier of the last glaciation and has been formed by the Hańcza glacial. However, many elements of contemporary relief, especially vast depressions and valleys of main rivers are already shaped in the outline of surface of glaciation deposits (Ber 1973, 1981). The thickness of quaternary glacial deposits on the area depends on the relief and formation of the top of pre-quaternary glacial deposits, and is 200–300 m. Because terminal moraines of two main glaciation periods and the subordinate modifications in glacier oscillation stages overlap, the relief of the area under discussion is characterized by considerable

differences in true height. The greatest heights exceed 270 m above sea level (Bogacki 1985), whereas bottoms of river valleys have the ordinates at 150–180 m a.s.l., and the Szeszupa valley bottom even some 120 m a.s.l. Such great differentiation in true heights (170–180 m) is rare in the terminal-morainic zone of East Baltic Lakelands.

The main forms of relief in the area are: morainic uplands, vast depressions, which are a meltwater after dead ice, and river valleys using the subglacial channels. A number of secondary relief forms, both positive and negative, occur there. Morainic uplands consists mainly of boulder clay, locally of glacial and glacifluvial sands and gravels with numerous boulders. These are undulate and hillocky areas much differentiated hypsometrically (Bogacki 1985). Usually the upland culminationa are hills and hillocks of terminal moraines, accumulations and extractions of true height 20–40 m (Kaftan and Pioruńska 1988). Hill ranges in the north-western part of the upland are 270–300 m a.s.l., in the eastern part they are lower: 180–200 m a.s.l. The glacial upland is cut by deep depressions at the bottom of which there are glacifluvial sands. These are meltwater depressions or erosive cutting downs. The biggest meltwater depressions in the central part of the area discussed is the Szeszupa depression; it covers 50 km^2 and its bottom is 50–80 m below the morainic uplands. The depression is drained by the Szeszupa towards north-east. Bigger erosive cutting, which are subglacial channels for glacial water, fill the lakes and rivers flowing out of them. These are the Czarna Hańcza and Szelmentka river valleys.

The secondary forms of relief are groups of forms of glacial accumulation (hillocks and hills of terminal moraines and extraction), crevice forms (hillocks and kame terraces, easkers) and also planty of small meltwater depressions and valleys of different genesis. Slopes of valleys and meltwater depressions are frequently cut down deeply; these are traces of erosive effect of waters flowing from uplands or of greatly advariced slope processes (Kaftan and Pioruńska 1988).

Surface and close to surface formations of the area disussed have a contrast lithological differentiation. Among them prevail morainic formations, smaller areas are covered by deposits of aquatic origin: outwash plain, crevice and stagnation accumulation; there is little Holocene deposits: peats, slime, alluvial and slope soils (Banaszuk 1985). Loams are the basic soil formation in the area examined, especially the medium loams. Typical are brown soils, leached and brown, and also pseudopodzolic soils (Banaszuk 1985). On coarse and loose sandy soils formed are rusty and podzolic soils; similar soil types occur on sands on gravel and on gravel.

2. CLIMATIC CONDITIONS

Northern part of East Suwałki Lakeland, including Suwałki Landscape Park, is in the Suwałki climatic region (Stopa-Boryczka and Martyn 1985). These

are the coldest areas in Poland, with sharp thermal contrasts between winter and summer (absolute range of air temperature fluctuations exceeds 60°C), a great number of frost days (up to 66) beginning in October and ends in March, characteristic is plenty of moisture of atmospheric origin, especially from intensive precipitation in summer months (Kluge 1988).

Macroclimatic conditions of the area are illustrated by data from the synoptical station at Suwałki, which allow to characterize the climate of the region as follows:

– mean annual total of solar radiation is 21.2 kJ · cm^{-2}, monthly – mean 1.77 kJ · cm^{-2}, daily mean – 59 J · cm^{-2}. Maximal values of total solar radiation are observed in June and July (109–103 J · cm^{-2} per day), and minimal – in December (8 J · cm^{-2} per day) (Table 1);

Table 1. Mean totals of solar radiation energy at Suwałki
(J · cm^{-2})

Months	Mean values	
	1958–1967*	1971–1977
January	309	396
February	574	674
March	1423	1636
April	2172	2202
May	2896	3212
June	3490	3397
July	3207	3390
August	2562	2957
September	1806	1832
October	937	893
November	301	377
December	245	249
Year	19922	21215

*Acc. to Chomicz (1977).

– mean monthly air temperatures fluctuate between –5.6°C (February) and +17.3°C (July), at an annual mean +6.1°C (Table 2);

– winter starts already on 26th of November and lasts till 24th of March, i.e., almost four months;

– the annual air humidity for that region has a peculiarity which distinguishes it from the rest of the country: the annual minimum is in June (68–72%), whereas the maximum is in December (90–92%);

Table 2. Long term mean air temperatures in °C in the Suwałki region
Acc. to Stopa-Boryczka and Martyn (1985)

Months	Mean values			
	maximal	minimal	annual	daily amplitude
January	–2.1	–7.3	–4.4	5.2
February	–2.6	9.2	–5.6	6.6
March	1.7	–6.1	–2.3	7.8
April	10.6	1.3	5.7	9.3
May	16.6	6.0	11.6	10.6
June	21.2	10.3	16.1	10.9
July	22.4	11.9	17.3	10.5
August	21.6	11.5	16.3	10.1
September	17.2	7.7	12.1	9.5
October	11.0	3.7	7.1	7.3
November	3.6	–0.8	1.4	4.4
December	–0.3	–4.7	–2.3	4.4
Year	10.1	2.0	6.1	8.1

– mean annual precipitation is 581 mm (maximal 829, minimal 334), maximal precipitation is in August (77 mm), minimal – in February (27 mm) (Table 3). The SLP area has higher precipitation than Suwałki (Table 3). The highest precipitation over a year is in the north-eastern part of the Park (surroundings of lake Hańcza – Fig. 1), the lowest – at the eastern and southern ends. In the years 1987–1989, annual mean precipitation was: 670 mm in the north-western part of the Park (raing gauge Hańcza), 641 mm in the central part (Sidora rain gauge), 575 mm in the southern part (Jeleniewo rain gauge), 592 mm on the area of lower Szeszupa and lower Szelmentka (Rutka Tartak rain gauge) and 549 mm in the eastern part of Szelmentka watershed (Aleksandrówka rain gauge);

– annually on the average there are 163 days with 0.1 mm precipitation of which 106 have a 1.0 mm precipitation;

– storm precipitation (10.0 mm) occures on average 14 days a year, mainly in summer between June and September;

– mean annual wind speed is 4.0 $m \cdot s^{-1}$ (Table 4) and has a rather balanced monthly distribution; on the average there are 48 days in a year with very strong wind ($v>10 \cdot s^{-1}$) mostly in winter months (between December and April). The most frequently observed winds are from the western sector, mainly from SW and W (Table 5). Monthly distribution of wind directions approximates generally the annual means, and only in spring (March-April) and late autumn (November) the contribution of winds from sectors SE and E increases (Table 5).

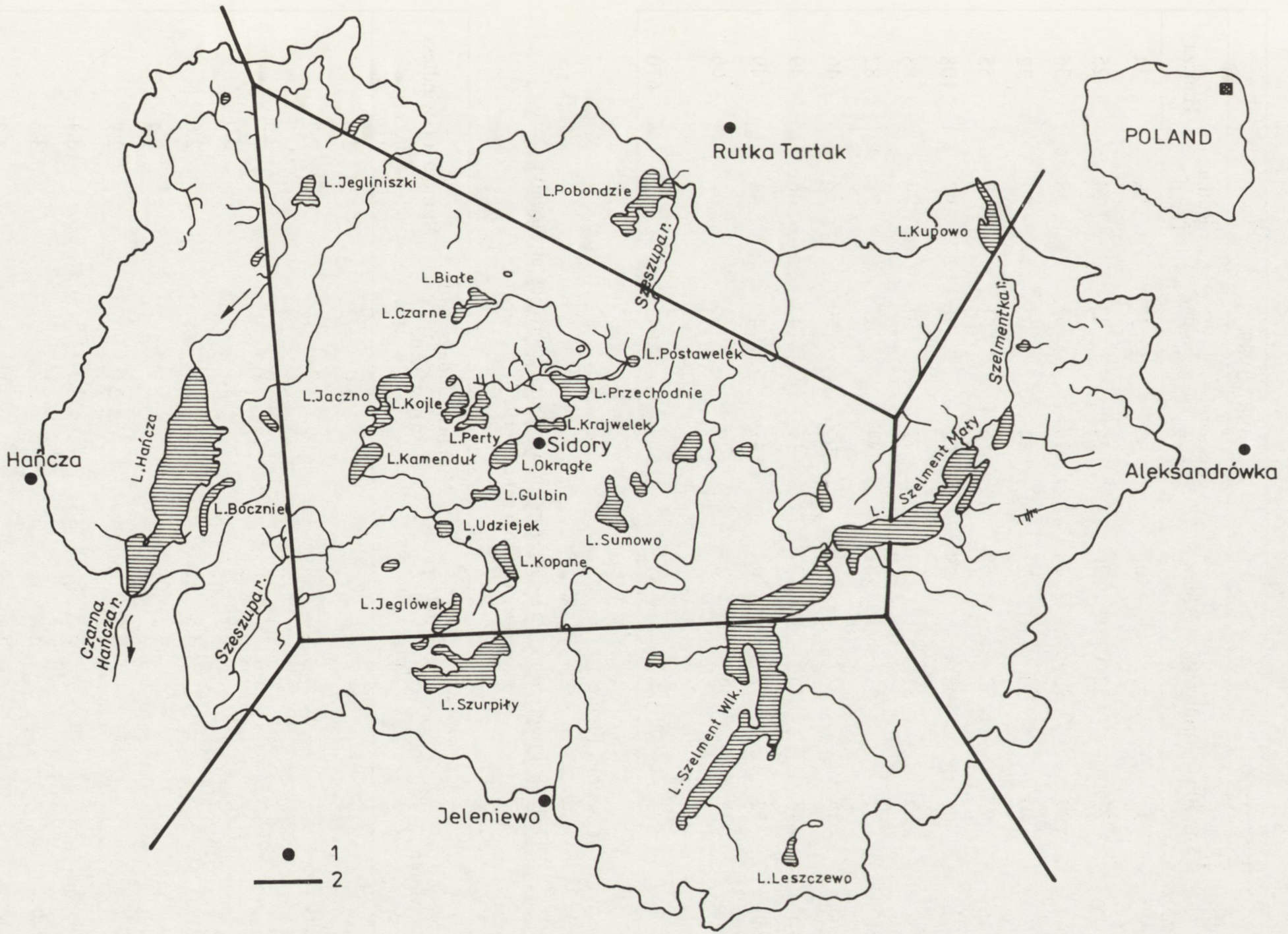

Fig. 1. Precipitation regions on the area of the Suwałki Landscape
1 – precipitation station, 2 – borders of precipitation regions

Table 3. Total precipitation (mean values) in Suwałki Landscape Park (mm)

Month	1951–1979	1987–1989					
	Suwałki	Suwałki	Jeleniewo*	Aleksandrówka*	Sidory*	Rutka Tartak*	Hańcza*
January	29	27	42	30	37	28	34
February	27	22	20	14	23	24	25
March	29	33	24	25	36	38	36
April	40	30	21	24	25	27	32
May	52	52	53	56	51	43	55
June	66	108	79	72	96	97	108
July	69	81	83	72	91	74	88
August	77	61	81	94	77	71	82
September	55	37	61	66	50	38	46
October	48	46	20	16	42	46	49
November	52	42	44	41	46	44	49
December	37	49	47	39	65	62	66
Year	581	588	575	549	641	592	670

*Precipitation stations Figure 1.

Table 4. Long term (1951–1965) mean wind characteristics at Suwałki
Acc. to Chomicz (1977)

Month	Average wind speed ($m \cdot s^{-1}$)	Number of days with strong wind ($v \geq 10\ m \cdot s^{-1}$)	Number of windless days
January	4.6	5.0	2.6
February	4.4	4.2	2.7
March	4.4	5.6	2.5
April	4.1	5.1	3.0
May	3.8	3.8	2.6
June	3.5	2.9	2.4
July	3.5	2.0	2.7
August	3.5	3.3	3.4
September	3.6	3.5	3.5
October	3.8	3.4	3.2
Novemver	4.5	5.3	1.9
December	4.4	4.3	1.7
Year	4.0	48.4	32.2

Table 5. Many years' (1951–1965) mean frequency of wind direction at Suwałki (%)
Acc. to Stopa-Boryczka and Martyn (1985)

Month	Wind direction								
	N	NE	E	SE	S	SW	W	NW	C
January	5.5	6.4	5.4	13.2	12.5	25.0	15.5	8.4	8.3
February	6.8	9.2	9.2	14.1	8.2	18.4	15.0	9.7	9.4
March	8.6	13.3	12.7	13.9	4.7	13.8	14.6	10.8	7.6
April	9.9	10.4	11.6	17.0	8.8	9.5	11.6	11.3	9.9
May	13.6	12.7	8.7	8.7	6.1	10.9	14.3	16.8	8.2
June	11.3	11.4	7.9	9.2	6.8	12.3	15.8	17.4	7.9
July	7.8	9.5	6.9	5.9	7.8	18.4	19.5	15.5	8.7
August	6.4	7.2	5.9	8.3	6.8	20.0	21.8	12.7	10.9
September	5.4	4.3	6.4	10.3	10.1	19.6	20.4	11.9	11.6
October	3.3	5.3	7.3	13.9	11.9	21.9	17.6	8.6	10.2
November	4.8	5.3	9.0	26.7	9.8	19.8	12.4	5.8	6.4
December	4.2	5.4	7.6	17.0	14.5	25.6	14.1	5.9	5.8
Year	7.3	8.4	8.2	13.2	9.0	17.9	16.1	11.2	8.7

3. HYDROLOGY

Water relations in the Lithuanian Lakeland are of decisive significance in maintaining natural balance (Głowacka 1988). Hydrology features of this area are characterized by a great number of lakes frequenctly involved in river outflow by a poorly developed channel network, by frequent changes of the rivercourse, along which overflow and tidal sections occur alternately, by numerous springs, great number of areas of closed depressions and a relatively dense net of periodical streams existing only in the period of spring floods and summer storms (Jarmużyński and Kaftan 1988).

The area lays in the Niemen catchment and is drained by three river systems: Czarna Hańcza, Szeszupa and its tributary Szelmentka (Fig. 2), which have on this area their springs. The Szeszupa is the main river of Suwałki Landscape Park. It flows through a vast depression, in the so-called Wytopisko Szeszupy, which is 18.8 km long and drains the area of 92.88 km^2 (Table 6). It runs towards north-east to Niemen amongst swamps and peat bogs in a bed varying in breadth and slope (Fig. 2 and 3); in the SLP it flows through six shallow lakes (the deepest lake Gulbin has an average depth of 5.6 m – Fig. 2 and 3) and by means of numerous streams, flowing into the river, drains also several other lakes in the Szeszupa depression (Fig. 4).

Table 6. Hydrographical division of the Szeszupa watershed (to the outflow from lake Pobondzie)
Explanations see Figure 2

Specification	Denotation in Fig. 2	Surface area (km^2)
1. Upper Szeszupa to the Szurpiłówka outlet	B 1.	15.88
2. Szurpiłówka including:		
– catchment area of lake Szurpiły	B 2.1.	11.14
– between lakes Szurpiły and Kopane	B 2.2.	0.58
– lake Kopane catchment area	B 2.3.	0.67
– between lake Kopane and Udziejek	B 2.4.	0.92
– lake Jeglówek catchment area	B 2.4.1.	1.80
– lake Udziejek catchment area	B 2.5.	0.72
– catchment area without flow	B 2.5.1.	0.25
– catchment area of the lake Udziejek outflow	B 2.6.	0.02
3. Jacznówka including:		
– catchment area to lake Jaczno	B 3.1.	6.22
– direct catchment area of lake Jaczno	B 3.2.	7.26
– catchment area of Potok Młyński	B 3.3.	3.48
– direct catchment area of lake Kamenduł	B 3.4.	1.06
– between lake Kamenduł and the outlet to the Szeszupa	B 3.5.	1.22

Table 6, continued

4.	The Szeszupa between the Szurpiłówka outlet and the outlet to lake Gulbin	B 4.	0.43
5.	Direct catchment area of lake Gulbin	B 5.	1.32
	Total catchment area of lake Gulbin		53.37
6.	The Szeszupa between lakes Gulbin and Okrągłe	B 6.	1.26
7.	Direct catchment area of lake Okrągłe	B 7.	0.54
	Total catchment area of lake Okrągłe		55.17
8.	The Szeszupa between lakes Okrągłe and Krajwelek	B 8.	0.78
9.	Direct catchment area of lake Krajwelek	B 9.	1.20
	Total catchment area of lake Krajwelek		57.15
10.	The Szeszupa between lakes Krajwelek and Przechodnie including the direct catchment area	B 10.	1.50
11.	The catchment area of Kojle-Perty lakes	B 10.1.	2.48
12.	Catchment area of the outflow from lake Perty	B 10.2.	3.24
	Total catchment area of take Przechodnie		64.37
13.	The Szeszupa between lakes Przechodnie and Postawelek	B 11.	2.00
14.	Direct catchment area of lake Postawelek	B 12.	0.14
	Total catchment area of lake Postawelek		66.51
15.	The Szeszupa between lakes Postawelek and Pobondzie	B 13.	4.02
16.	Catchment area of lake Sumowo	B 13.1.	4.68
17.	Catchment area of lake Jałowo	B 13.2.	7.59
18.	Direct catchment area of lake Pobondzie	B 14.	10.08
	Total catchment area of lake Pobondzie		92.88

The biggest Szeszupa tributaries on this area are rivers Szurpiłówka and Jacznówka (Fig. 4). The Szurpiłówka is the right tributary of the Szeszupa, it flows out of lake Szurpiły (acc. to Kaftan – unpubl. data it flows from lake Kluczysko) and generally heading to the north it flows through lake Kopane and then lake Udziejek, below which it flows into the Szeszupa (Figs. 2, 4). Below the outflow from lake Kopane this river joins a stream draining lake Jegłówek. The river is about 6 km long and drains a surface area of 16.36 km^2 (Table 6). The Jacznówka is the left tributary of the Szeszupa and flows into it 250 m below the Szurpiłówka outlet (Fig. 2 and 4). It flows out of lake Jaczno, from which by a short isthmus it runs to lake Kamenduł, from which it flows out eastwards through a narrow ravined valley; between lakes Jaczno and Kamenduł it joins a stream called Potok Młyński (Fig. 4). The river is about 5 km long, the catchment area – 19.64 km^2 (Table 6). The Szeszupa is also greatly supplied by springs occurring first of all abundantly on the eastern side of the depression (Fig. 2).

The Szeszupa river system (to its outflow from lake Pobondzie) consists of 52 sections of the 1 order of an average length of 0.39 km, 11 sections of the 2 order

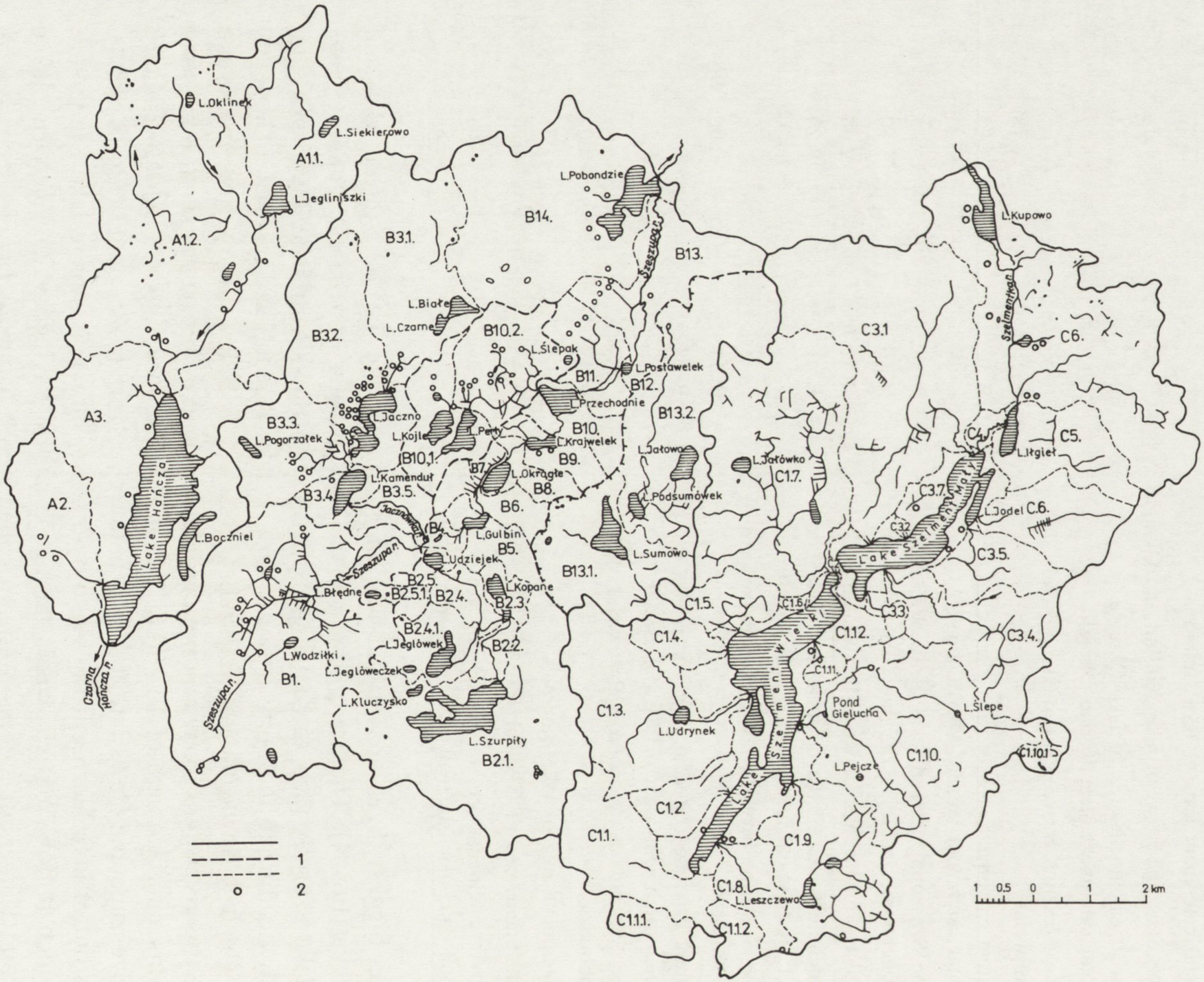

Fig. 2. Hydrographical division of the Suwałki Landscape Park
A – the Czarna Hańcza watershed, B – the Szeszupa watershed, C – the Szelmentka watershed, 1 – water dividies, 2 – sources

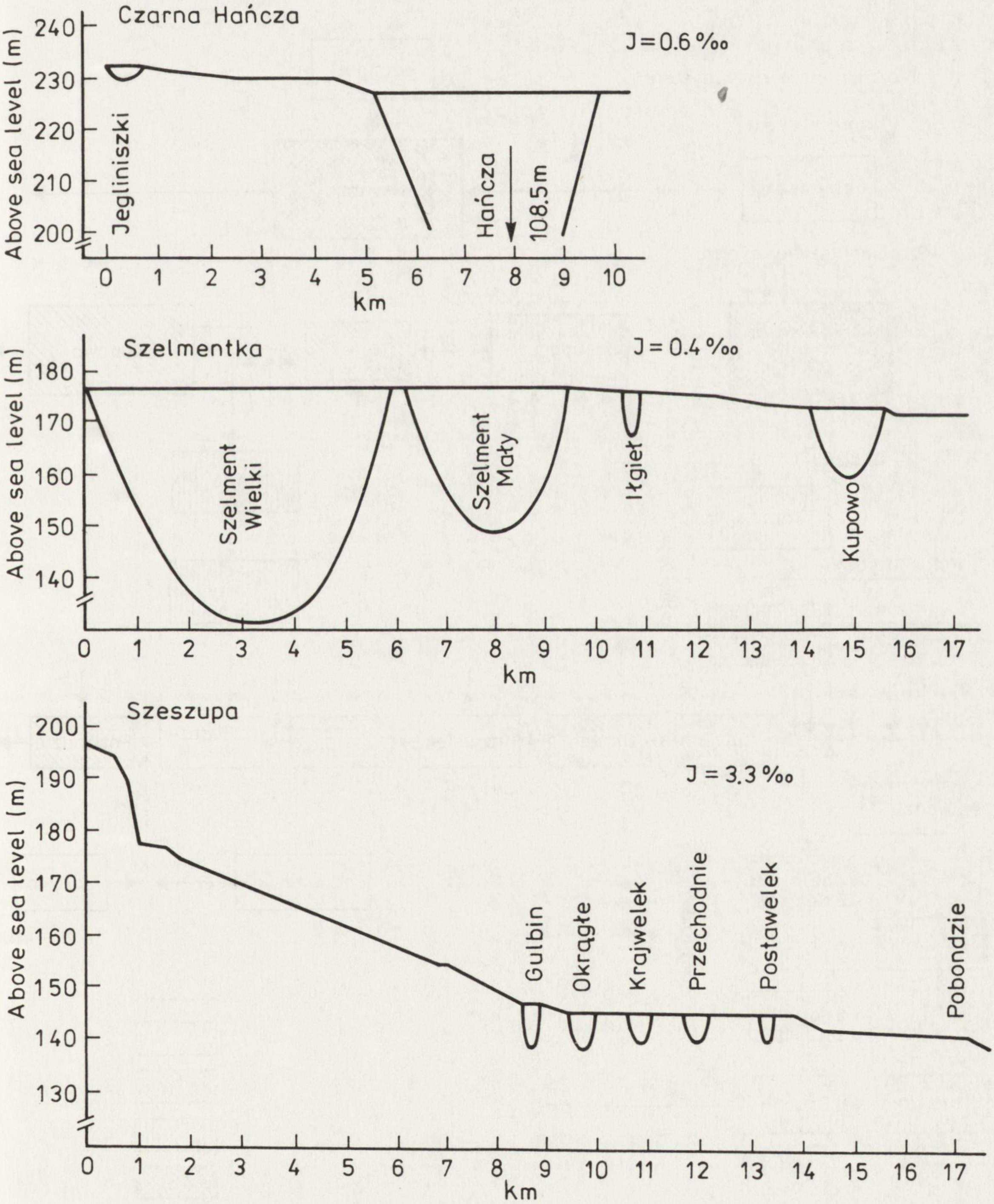

Fig. 3. Longitudinal profiles of rivers of the Suwałki Landscape Park
J – mean declivity

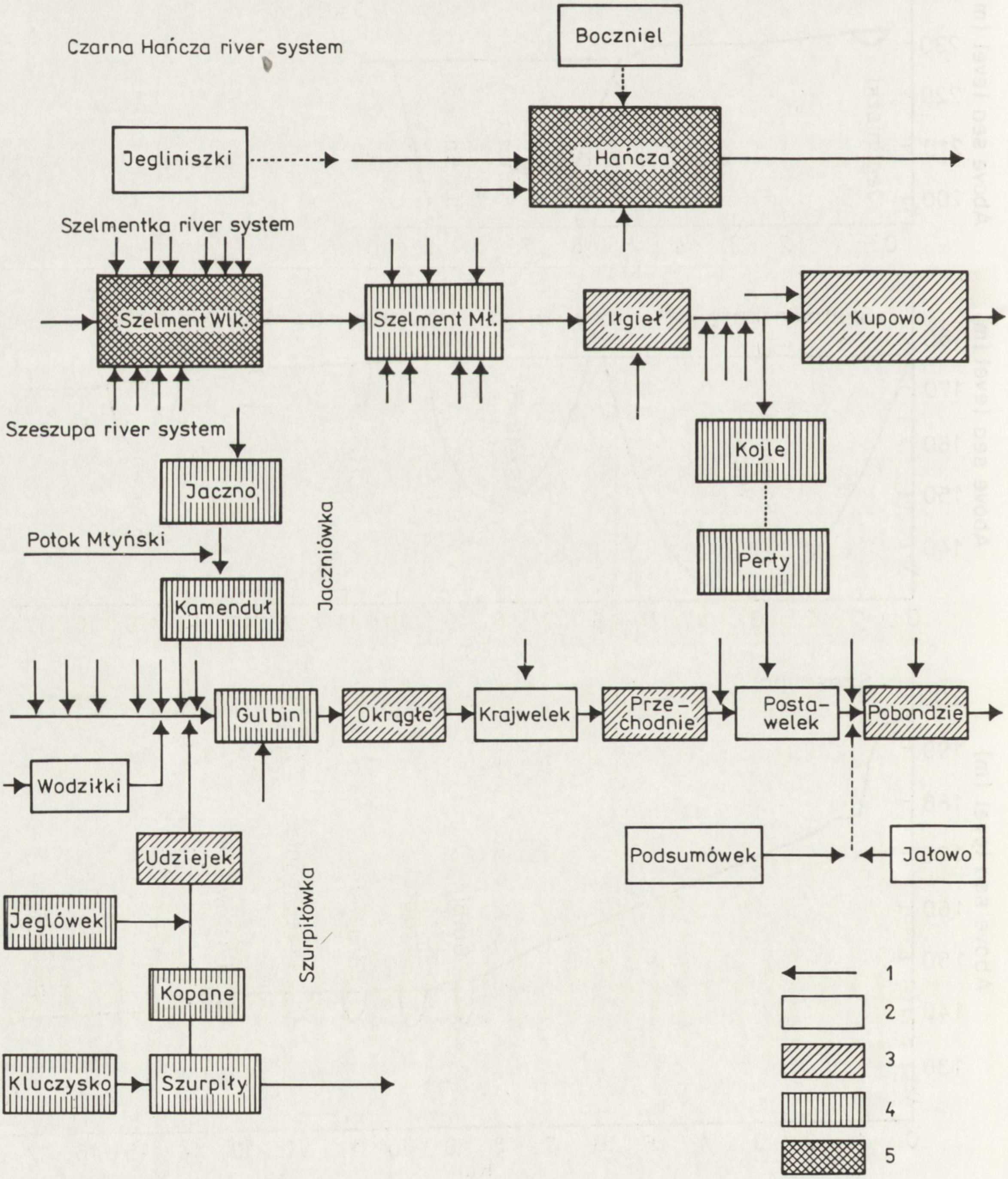

Fig. 4. River-lake patterns in the Suwałki Landscape Park
1 – streams; mean lake depth: 2 – < 3 m, 3 – 3–5 m, 4 – 5–10 m, 5 – >10 m

of an average length of 1.27 km, 2 sections of the 3 order of an average length of 4.47 km and 1 section of the 4 order 4.95 km long (Table 7). The systems of this river develops according to the law of number of streams. Bifurcation rate $\overline{R}_B$ equal 4.05 progression by a quotient, whereas acc. to the law of length of streams it develops only to the 3 order (only to the 3 order the length of a section tends to progress geometrically as the order of streams is increased by a quotient of while length rate R_L is 3.29 (Bajkiewicz-Grabowska 1987).

Table 7. Selected characteristic of Suwałki Landscape Park channel network structure

River	Order of stream Ni	Number of sections of N order	Bifurcation index $\overline{R}b$	Length of streams Li (km)	Average length of stream of N order (km)	Index of average stream length ($\overline{R}J$)
The Szeszupa (to the outflow from lake Pobondzie)	1	51	4.64	20.04	0.39	
	2	11	5.50	13.96	1.27	3.26
	3	2	2.00	8.94	4.47	3.52
	4	1		4.95	4.95	1.11
		Σ 65	$\overline{R}b$ = 4.05	Σ 47.89	–	$\overline{R}J$ = 2.63
The Szelmentka (to the outflow from lake Kupowo)	1	49	3.50	31.30	0.64	
	2	14	4.67	22.00	1.57	2.45
	3	3	3.00	4.13	1.38	0.88
	4	1		4.28	4.28	3.10
		Σ 67	$\overline{R}b$ = 3.72	Σ 61.71	–	$\overline{R}J$ = 2.14
The Czarna Hańcza (to the outflow from lake Hańcza)	1	12	12.0	5.78	0.48	
	2	1		8.55	8.55	17.8
		Σ 13	$\overline{R}b$ = 12.0	Σ 14.33	–	$\overline{R}J$ = 17.8

The Szelmentka is a tributary of the Szeszupa and also runs initially to the north-east utilizing the subglacial channels, changing after wards its direction to a northern one (Fig. 2). The river begins from lake Szelment Wielki and flow, runs through lakes Szelment Mały, Iłgieł and Kupowo (Figs. 2, 4). The river slope is gentle (Fig. 3). To the outflow from lake Kupowo the river is 17.2 km long and drains a surface area of 96.64 km^2 (Table 8). The Szelmentka river system is poorly organized, similarily as of other rivers in that area. It consists of 49 sections of the 1 order of an average length of 0.64 km, 14 sections of the 2 order of an average length of 1.57 km, 3 sections of the 3 order of an average length of 1.38 km and 1 section of the 4 order 4.28 km long. This is the river's order when outflowing from lake Szelment Wielki. The system of this lake develops according to the law of the number of streams (mean bifurcation rate $\overline{R}b$ = 3.72) but does not develop acc. to the law of stream lengths (Table 7).

The Czarna Hańcza flows out of lake Jegliniszki (Podział hydrograficzny Polski (1983). At first it is a periodical stream and only 2.5 km above the outlet to

lake Hańcza, it is supplied by several springs and numerous effluents draining the area of glacial upland and as a stable stream supplies lake Hańcza. It flows out of it as a river (Fig. 2) running at first in a deep channel. The Czarna Hańcza river system is poorly organized: it consists of 12 streams of the 1 order of an average length 0.48 km and 1 section of the 2 order (Table 6). On a length of ca 9.3 km (to the outflow from lake Hańcza) this river drains the area of 41.36 km^2 (Table 9).

Table 8. Hydrographical division of the Szelmentka catchment area
(to the outflow from lake Kupowo)

Specification*	Surface area (km^2)
Lake Szelment Wielki catchment area including:	
– catchment area C 1.1.1.	1.50
– catchment area C 1.1.2.	0.90
– catchment area C 1.1.	4.08
– catchment area C 1.2.	1.47
– catchment area C 1.3.	6.33
– catchment area C 1.4.	1.11
– catchment area C 1.5.	1.58
– catchment area C 1.6.	0.13
– catchment area C 1.7.	10.91
– catchment area C 1.8.	1.72
– catchment area C 1.9.	5.24
– catchment area C 1.10.	10.69
– catchment area C 1.11.	0.40
– catchment area C 1.12. (direct catchment area of lake Szelment Wielki)	8.47
Total catchment area of lake Szelment Wielki	54.08
Catchment area between lakes Szelment Wielki and Szelment Mały C 2.	0.04
Lake Szelment Mały catchment area including:	
– catchment area C 3.1.	12.42
– catchment area C 3.2.	0.06
– catchment area C 3.3.	0.37
– catchment area C 3.4.	4.35
– catchment area C 3.5.	2.03
– catchment area C 3.6.	2.96
– catchment area C 3.7. (direct catchment area of lake Szelment Mały)	3.96
Total catchment area of lake Szelment Mały	80.27
Catchment area between lakes Szelment Mały and Iłgieł C 4.	0.35
Direct catchment area of lake Iłgieł C 5.	3.53
Total catchment area of lake Iłgieł	84.15
The Szelmentka catchment area from the outflow from lake Iłgieł to the outflow from lake Kupowo C 6.	12.49
Total catchment area of lake Kupowo	96.64

*Explanations see Figure 2.

Table 9. Hydrographical division of the Czarna Hańcza catchment area (to the outflow from lake Hańcza)

Specification	Designation*	Surface area (km^2)
Lake Jegliniszki catchment area	A 1.1.	7.59
Catchment area between lakes Jegliniszki and Hańcza	A 1.2.	16.79
Catchment area of the tributary of lake Hańcza	A 2.	3.82
Direct catchment area of lake Hańcza	A 3.	13.16
Total catchment area of lake Hańcza		41.36

*For explanations see Figure 2.

The main element of hydrology of Suwałki Landscape Park and of the whole Lithuanian Lakeland are the lakes. These are small water bodies (only five lakes have a surface area greater than 50 ha). 12 lakes have a maximal depth over 10 m (Table 10 and 11). The largest and deepest lakes of the SLP are subglacial type formed as a result of evorsive-erosive action of glacial waters (lakes Hańcza, Szelment Wielki and Szelment Mały). Still the majority of lakes are formed by meltwater for instance Szurpiły lake. Generally these are lakes with inflow and outflow (Figs. 2–4) belonging to river-lake systems. The majority of lakes are in the Szeszupa catchment area (Table 11).

In Suwałki Landscape Park very important in water cycling are various kinds of concentrated or non-concentrated outflows of underground waters, i.e., springs, and seepages. The existence of 109 springs was recorded (Nowakowski, unpubl. data). The majority are found in the Szeszupa watershed (Fig. 2). They are concentrated first of all in the zone of western slope of the meltwater depression; some are on the eastern slope and in the vicinity of river bed. According to Nowakowski (unpubl. data) these springs drain mostly deeper ground water horizons and are also supplied by ground and subsoil waters. Springs discharging deeper ground water are found at the edge of intramoraine layers. Springs drain water from glacial deposits within the upland, from outwash plains and alluvial fans. Springs of subsoil water come from fine partly medium sand filling depressions between the moraine mounds and extractions in the region of lake Pobondzie (Nowakowski, unpubl. data). Within the Szeszupa watershed, up to the outflow from lake Pobondzie, 74 springs were recorded. In the Szelmentka watershes 18 springs were observed. Their occurrence is limited first of all to slopes of the river valley and two subglacial channel lakes in its sequence (Fig. 2). According to Nowakowski (unpubl. data) these springs drain ground waters, whereas they are supplied by waters in glacial and outwash plain sands of valley type. These are usually free flow springs, mainly simple and simple-dam ones. Only in two springs the water comes out under pressure from the

Table 10. Basic morphometric data on Suwałki Landscape Park lakes
Acc. to S. Sakowicz Inland Fisheries Institute

Lake	Lake surface Al (ha)	Lake volume Vl (mln m^3)	Depth (m)		Length of shoreline L (m)	Ratio of shoreline to lake surface L/Al ($m \cdot ha^{-1}$)	Development of shoreline $\frac{L}{2\sqrt{Al}}$
			maximal	mean			
The Czarna Hańcza catchment area:							
Jegliniszki	16	0.198	2.4	1.2	2200	146	1.55
Boczniel	18.2	0.324	4.3	1.8	3175	174	2.10
Hańcza	311.4	120.364	108.5	38.7	11750	38	1.88
The Szelmentka catchment area:							
Szelment Wielki	356.1	53.492	45.0	15.0	19100	54	2.86
Szelment Mały	168.5	12.577	28.5	7.4	9525	56	2.00
Iłgieł	17.1	0.699	9.7	4.0	2000	117	1.30
Kupowo	32.8	1.625	13.2	5.0	3725	113	1.80
The Szeszupa catchment area:							
Kluczysko	3.64	0.212	13.6	5.8	926	254	1.37
Szurpiły	80.9	8.169	46.8	10.0	6650	86	2.19
Kopane	15.1	0.852	18.7	5.6	1925	128	1.40

Jeglówek	19.6	1.879	26.6	9.6	2370	134	1.68
Udziejek	6.1	0.229	7.2	3.8	996	163	1.14
Jaczno	39.67	3.965	25.0	10.0	5000	126	2.24
Kameduł	25.5	1.730	24.5	6.8	2300	90	1.30
Kojle	15.4	1.351	33.0	9.0	2044	133	1.47
Perty	19.7	1.183	31.0	6.0	2592	132	1.65
Gulbin	7.4	0.266	9.4	5.6	1125	152	1.20
Okrągłe	17.4	0.817	8.0	4.7	1723	99	1.16
Krajwelek	15.8	0.474	6.0	3.3			
Przechodnie	28.3	0.944	6.3	3.3	2209	78	1.17
Postawelek	3.4	0.092	5.4	2.6			1.84
Pobondzie	53.1	1.918	10.0	3.6	4750	89	

Table 11. Lakes of Suwałki Landscape Park according to river basins

The Niemen river basin		
A. The Czarna Hańcza catchment area	B–C The Szeszupa catchment area	
	B. The Szeszupa catchment area	C. The Szelmentka catchment area
	Lakes over 50 ha	
Hańcza	Szurpiły	Szelment Wielki
	Pobondzie	Szelment Mały
	Lakes below 50 ha	
Boczniel	Jaczno	Kupowo
Jegliniszki	Przechodnie	Iłgieł
Oklinek	Kamenduł	Jałówek
Siekierowo	Perty	Udrynek
	Okrągłe	Leszczewo
	Jeglówek	Pejcze
	Kopane	Ślepe
	Kojle	Staw Gielucha
	Postawelek	
	Krajwelek	
	Gulbin	
	Udziejek	
	Kluczysko	
	Wodziłki	
	Błędne	
	Jeglóweczek	
	Pogorzałek	
	Sumowo	
	Sumówek	
	Jałowo	
	Ślepak	
	Czarne	
	Białe	

sandy-gravel interbeddings between loams. On the Czarna Hańcza watershed 18 springs were recorded (Fig. 2) (Nowakowski, unpubl. data), mostly in the river valley and in small tributary valleys, formed as the role a subglacial channels. These sources drain the ground waters from glacial sands and gravels and from valley outwash plain. At the slopes of valley and basin of lake Hańcza there are springs sources, and dam ones at the bottom of slopes or in the valley.

Areas of closed depressions in the Suwałki Landscape Park are significant in the water cycling there (Kaftan and Pioruńska 1988). According to Kaftan (unpubl. data) 52% of the Park surface is drained by constant channel network, 27% joins the surface runoff only periodically, and 21% is permanently excluded from this runoff (areas of closed depressions). In particular fragments of the SLP and its cover the contribution of areas of closed depressions may be even greater as regards the surface, e.g., in the Szerpiłówka watershed 55% of areas are excluded from surface runoff, 24% of areas with periodical runoff and only 21% with permanent channel network (Kaftan, unpubl. data).

4. SUMMARY

Briefly described are the main features of the relief of Suwałki Landscape Park (morainic upland, meltwater depression and river valleys), the character of surface formations, soils formed on them, climatic conditions of the region (Tables 1–5), indicating the differences in total annual precipitation in particular fragments of the Park (Fig. 1) and characterizing the hydrographical network (Figs. 2–4). The morphometry of main river-lake systems are described: Szeszupa (Table 6 and 7), Szelmentka (Table 8) and Czarna Hańcza (Table 9). Morphometric parameters of lakes (Table 10 and 11) and their relations with rivers are given (Fig. 4). Numerous springs and areas of closed depressions are pointed out as a significant and frequent component of the SLP.

5. POLISH SUMMARY

Opisano zwięźle podstawowe cechy rzeźby Suwalskiego Parku Krajobrazowego (wysoczyzny morenowe, obniżenie wytopiskowe i doliny rzeczne), charakter utworów powierzchniowych i wytworzonych na nich gleb, warunki klimatyczne regionu (tab. 1), ze zwróceniem uwagi na różnice w ilości sum rocznych opadów, jakie otrzymują poszczególne fragmenty Parku (rys. 1), a także scharakteryzowano sieć hydrograficzną (rys. 2–4). Opisano cechy morfometryczne głównych systemów rzeczno-jeziornych: Szeszupy (tab. 6, 7), Szelmentki (tab. 8) i Czarnej Hańczy (tab. 9). Podano cechy morfometryczne jezior (tab. 10, 11) i ich powiązanie z rzekami (rys. 4). Wskazano na liczne źródła i obszary bezodpływowe jako ważny i częsty składnik krajobrazu SPK.

6. REFERENCES

1. Bajkiewicz-Grabowska E. 1987 – Systemy rzeczne i stopień ich uporządkowania [River systems and the degree of their development] – Przegl. geofiz. 32: 303–318.

2. Banaszuk H. 1985 – Środowisko przyrodnicze. Gleby [Natural environment. Soils] (In: Województwo suwalskie. Studia i materiały. Ośrodek Badań Naukowych w Białymstoku i Instytut Geografii i Przestrzennego Zagospodarowania PAN [Suwałki province. Studies and materials. Scientific Centre at Białystok and the Institute of Geography and Spatial Management of the Polish Academy of Sciences] – Białystok, 59–80.
3. Ber A. 1973 – Stratygrafia i rozwój czwartorzędu Pojezierza Suwalskiego. [Stratigraphy and development of the Quaternary of the Suwałki Lakeland.] Przewodnik XLV Zjazdu Polskiego Towarzystwa Geograficznego na Ziemi Suwalsko-Augustowskiej [XLV of Polish Geographical Society Congress in Suwałki-Augustów Land] – Wydawnictwa Geologiczne, Warszawa, 75–111.
4. Ber A. 1981 – Pojezierze Suwalsko-Augustowskie. Przewodnik Geologiczny [Suwałki-Augustów Lakeland. Geological quide] – Wydawnictwa Geologiczne, Warszawa, 199 pp.
5. Bogacki M. 1985 – Środowisko przyrodnicze. Budowa geologiczna i ukształtowanie powierzchni [Natural environment. Geological structure and formation of the surface] (In: Województwo suwalskie. Studia i materiały) [Suwałki province. Studies and materials.] – Ośrodek Badań Naukowych, Instytut Geografii i Przestrzennego Zagospodarowania PAN, Białystok, Warszawa, 11–58.
6. Chomicz K. 1977 – Materiały do poznania agroklimatu [Materials to Polish agroclimate] – Państwowe Wydawnictwo Naukowe, Warszawa, 296 pp.
7. Głowacka I. 1988 – Ekologiczny System Obszarów Chronionych jako podstawa koncepcji ochrony walorów środowiska przyrodniczego Suwalszczyzny [Ecological System of Protected Areas as basic conception of protecting natural environment of Suwałki region] – Człow. Środ. 12: 27–40.
8. Jarmużyńska T., Kaftan J. 1988 – Stan i ocena stosunków wodnych Suwalszczyzny [State and estimation of water relations of the Suwałki region] – Człow. Środ. 12: 79–98.
9. Kaftan J., Pioruńska K. 1988 – Rzeźba terenu Suwalszczyzny i jej współczesne zmiany [Relief of the Suwałki region and its contemporary changes] – Człow. Środ. 12: 57–78.
10. Kluge M. 1988 – Uwarunkowania klimatyczne Suwalszczyzny [Climatic conditions of the Suwałki region] – Człow. Środ. 12: 41–58.
11. Kondracki J. 1988 – Geografia fizyczna Polski [Physical geography of Poland] – Państwowe Wydawnictwo Naukowe, Warszawa, 463 pp.
12. Podział hydrograficzny Polski [Hydrographical division of Poland] 1983 – Instytut Meteorologii i Gospodarki Wodnej, Warszawa, 924 pp.
13. Richling A. 1985 – Środowisko przyrodnicze. Ocena warunków przyrodniczych w granicach mikroregionów [Natural environment. Estimation of natural conditions within microregions] (In: Województwo suwalskie. Studia i materiały [Suwałki province. Studies and materials) – Ośrodek Badań Naukowych, Instytut Geografii i Przestrzennego Zagospodarowania PAN, Białystok, Warszawa, 205–216.
14. Stopa-Boryczka M., Martyn D. 1985 – Środowisko przyrodnicze. Klimat [Natural environment. Climate] (In: Województwo suwalskie. Studia i materiały) [Suwałki province. Studies and materials] – Ośrodek Badań Naukowych, Instytut Geografii i Przestrzennego Zagospodarowania PAN, Białystok, Warszawa. 81–118.