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CHANGES IN FOREST COVER OF SZCZECIN LOWLAND FROM THE 16th TO THE END OF THE 20th CENTURY, IN RELATION TO SOIL COVER

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ABSTRACT

The area of Szczecin Lowland used to be covered by forests. Only the wetlands, flooded areas and coastal sand dunes were not covered by forest. Changes of the use of land depended mostly on soil texture and hypsometry, which can be seen clearly in case of forests - their largest complexes remained on sandy terraces, outwash plains and terminal moraines.

The analysis of forest area changes has shown that as early as in the 14th/16th century, woodiness was definitely connected with soil quality. At that time the smallest forestation (below 25%) was on soils formed from lake silts (black earth) and brown and lessive soils from sandy loams. On the poorest soils the area covered by forests exceeded 90%. Between the 16th and 18th century, the forest areas grew much smaller. Their total area decreased from 55% to 26%. By the end of the 18th century the whole area of black earths was taken for agricultural use. Small patches of forests remained on poorer brown and lessive soils. Areas of sandy and heavy loam soils suffered a loss of about 50% of forests that had been there in the 16th century. From 1790 to 1930 the brown and lessive soils developed from silt and sandy loams underwent complete deforestation, whereas areas belonging to the other groups of soil have not suffered major changes. After WW2 the forest area increased to 28% (1986). This pertains particularly to areas of rusty soils, where the forested land increased by about 20%.

Key words: historical analysis, landscape, forest cover, Pomerania

INTRODUCTION

In the past, forest used to cover most of the area of Szczecin Lowland. Only the wetlands, flooded areas and sand dunes along the seashore were not covered by forest. Due to the development of agriculture and spreading settlement, the area of cultivated land grew that of forest fragmentation, which in turn caused several changes of the flora and fauna [8]. The primeval, rather monotonous landscape has become refined and diversified, and consisted of fields, meadows and natural forests as well [6].

Changes of the intensity of land use depended mostly on the soil texture, configuration of the surface, which can be clearly seen in the case of forests the largest patches of which remained on sandy terraces, on outwash plains and terminal moraine. The first large scale thinning of forests in this area occurred during colonisation in the 8th to 9th centuries [7]. At the beginning of the 12th century Slavic settlements were established along better soils, and the terminal moraine and outwash plains were poorly settled [11]. At the time of the second colonisation (14th to 16th century) the percentage of forests in the former Szczecin District was about 66%. In 1980 the forest area has shrunk considerably, though some larger forests, like the Puszcza Wkrzańska and Goleniowska have endured, and their area decreased only slightly [7]. The shrinking of forests in Pomerania in the 19th century was also due to an increased demand for wool, thus for pastures for sheep. This lasted to about 1870, and the area of forests decreased by a dozen or so percent. After the French-Prussian war (1871) the sheep keeping was abandoned, and the grazing areas were afforested again [9]. After Second World War (WW2), due to economical changes in Poland the area of forests in Szczecin Lowland increased again. It can be assumed that due to subsidies the area of forests will increase, according to the act of Parliament of June 8.2001 about afforestation of agricultural land.

This study aimed at presenting changes of forest areas in Szczecin Lowland from the 16th to 20th centuries, considering various soil conditions in that area.

MATERIAL AND METHODS

The area of forests in history was assessed on the basis of utilisation charts by Hartnack [4], scale of 1:1,500,000. This author developed the forest charts basing upon charts: Lubinus 1618, Zierhold 1789, Engelhard 1811. Data from 1930 were taken from the Chart of the German Reich, scale of 1:100,000, and Survey Map of Central Europe, scale of 1:300,000. The condition of forests at the end of the 20th century was described according to Polish topographic charts, scale of 1:200,000, published by WZK in the nineties, showing the conditions of forests in 1986-1987.

Division of the area into meso-regions based upon physico-geographic regionalization of Poland [5].

The digital map of soil cover based upon soil chart of the scale of 1:500,000, published by Wydawnictwo Geologiczne in 1972. The authors into 10 classes grouped all the existing soil contours. The main criterion of the division was a combination of the soil type and texture. The following soil types were distinguished:

-muck, mucky-like, gley, alluvial (Fibric Histosols, Gleyosols, Fluvisols)	(M)
-peat (Histosols)	(T)
-black earth (Mollic Gleyosols and Gleyic Phaeozems)	(D)
-brown earth and lessive, from silt (Cambisols and Luvisols)	(BP1)
-brown earth and lessive, from sandy loam, and clay sand on clay	(BP2)
-brown earth and lessive, from heavy and medium loam	(BP3)
-brown earth and lessive, from loamy sands	(BP4)
-rusty soils, from loamy sands (Cambic Arenosols)	(RD1)
-rusty soils, from sands (Cambic Podzols)	(RD2)
-podzols, from loose sand (Haplic and Umbric Podzols)	(A)

All cartographic materials were warped and registered in the ArcInfo (WGS 84 projection), and later the outlines of forests and soils were digitalized. Using the Idrisi programme the polygons were rastered, and the changes of the forested areas calculated according to soil conditions.

STUDIED AREA

The tested area was of 8040 km^2. It consisted mainly of Szczecin Lowland, with minor inclusions of Western Pomerania Lakeland (Fig.1, Table 1). The western and northern part of this area is now the Polish border, whereas the southern part is the former border of Pomerania Province (prior to WW2). The eastern border was designed along the 16th meridian of the east geographic longitude.

Fig. 1. Study area (meso-regions - according to Kondracki 2000)

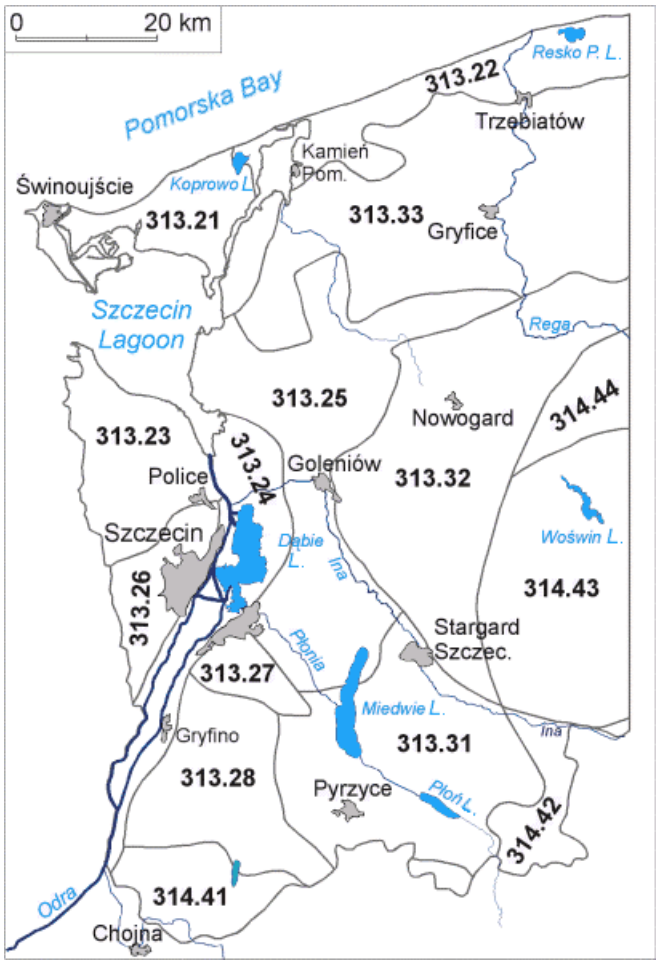


Table 1. Area of meso-regions

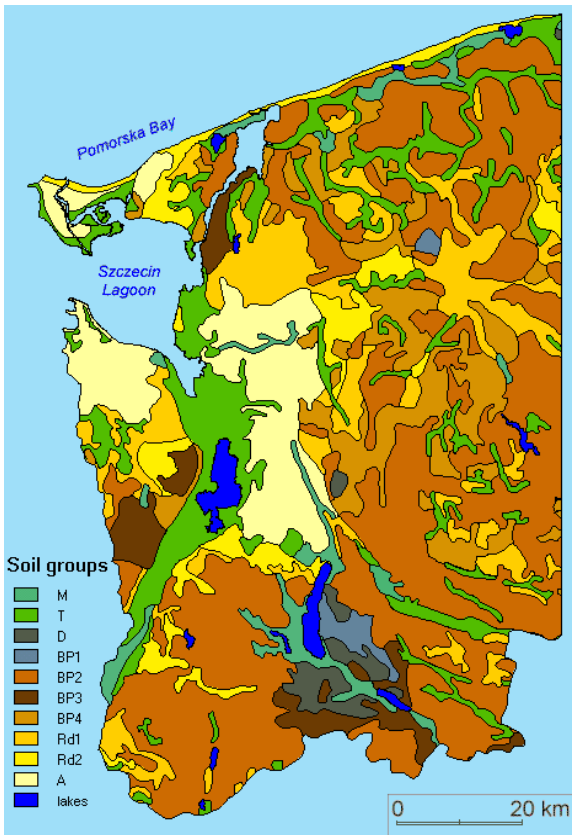
Meso-region	Number of meso-region	Area (ha)	Percentage of meso-region in study area (%)
Trzebiatów Coast	313.22	480.05	94.2
Gryfice Plain	313.33	1280.90	68.9
Wkrzańska Plain	313.23	384.68	100.0
Goleniów Plain	313.25	990.86	100.0
Nowogard Plain	313.32	1111.12	93.0
Ińskie Lakeland	314.43	773.13	73.1
Stargard-Pyrzyce Plain	313.31	858.13	95.2
Bukowe Hills	313.27	114.22	100.0
Lower Odra Valley	313.24	464.94	88.4
Szczecin Hills	313.26	205.96	100.0
Wełtyn Plain	313.28	468.67	98.6
Myślibórz Lakeland	314.41	265.23	20.0
Choszczno Lakeland	314.42	182.52	28.0
Łobez Upland	314.44	165.11	14.6
Wolin i Uznam	313.21	294.38	100.0

The landscape of the studied area had been formed during the last glaciation (Vistulian). Flat and undulating plains of the ground moraine, split by a net of subglacial channels and river valleys are the dominant landscape features. Characteristic of this region are also wide, sandy areas of the Odra flood plain and Pyrzyce ice-dammed basin, filled with silt and clay formations. Lessive and brown earth cover the largest area upon clay and loamy sands (Table 2). These are present mostly in the south, east and north-east part of this region (Fig. 2). In the central and west central part sandy soils are dominant, common particularly on the Odra flood plain. Western Pomerania is characterised by a large area of black earths in the region of Pyrzyce ice-dammed basin, which because of their fertility were deforested rather early [2,3].

Table 2. Percentage share soil groups in meso-region area

Nubmer of meso-region	M	Tn	D	BP 1	BP 2	BP 3	BP 4	Rd 1	Rd 2	A
313.21	---	27.9	---	---	10.0	---	6.3	5.1	25.4	25.4
313.22	14.2	24.3	0.4	---	31.4	9.7	6.6	2.4	11.0	---
313.23	1.2	22.1	---	---	2.0	---	0.8	25.5	3.1	45.3
313.24	7.4	66.1	---	---	5.3	1.0	2.3	5.1	4.5	8.4
313.25	5.7	12.0	0.2	0.1	7.4	---	2.6	14.4	13.6	44.1
313.26	2.1	1.1	---	---	16.5	49.6	8.9	8.3	13.6	---
313.27	2.8	---	---	---	73.3	---	---	9.4	14.5	---
313.28	0.2	2.0	---	---	85.8	---	---	2.0	10.0	---
313.31	12.6	6.3	14.3	6.9	41.9	15.7	---	2.2	0.1	---
313.32	0.0	3.8	0.8	---	43.3	---	31.2	17.5	2.2	1.1
313.33	0.1	17.0	---	1.0	47.9	0.0	10.6	20.7	2.0	0.7
314.41	---	4.5	---	---	75.2	0.5	---	17.6	2.2	---
314.42	---	17.8	---	---	67.2	4.7	---	10.4	---	---
314.43	---	10.7	---	---	62.9	---	15.3	11.1	---	---
314.44	3.3	1.4	---	---	45.0	---	29.3	20.9	---	---

Fig. 2. Soil cover differentiation within study area



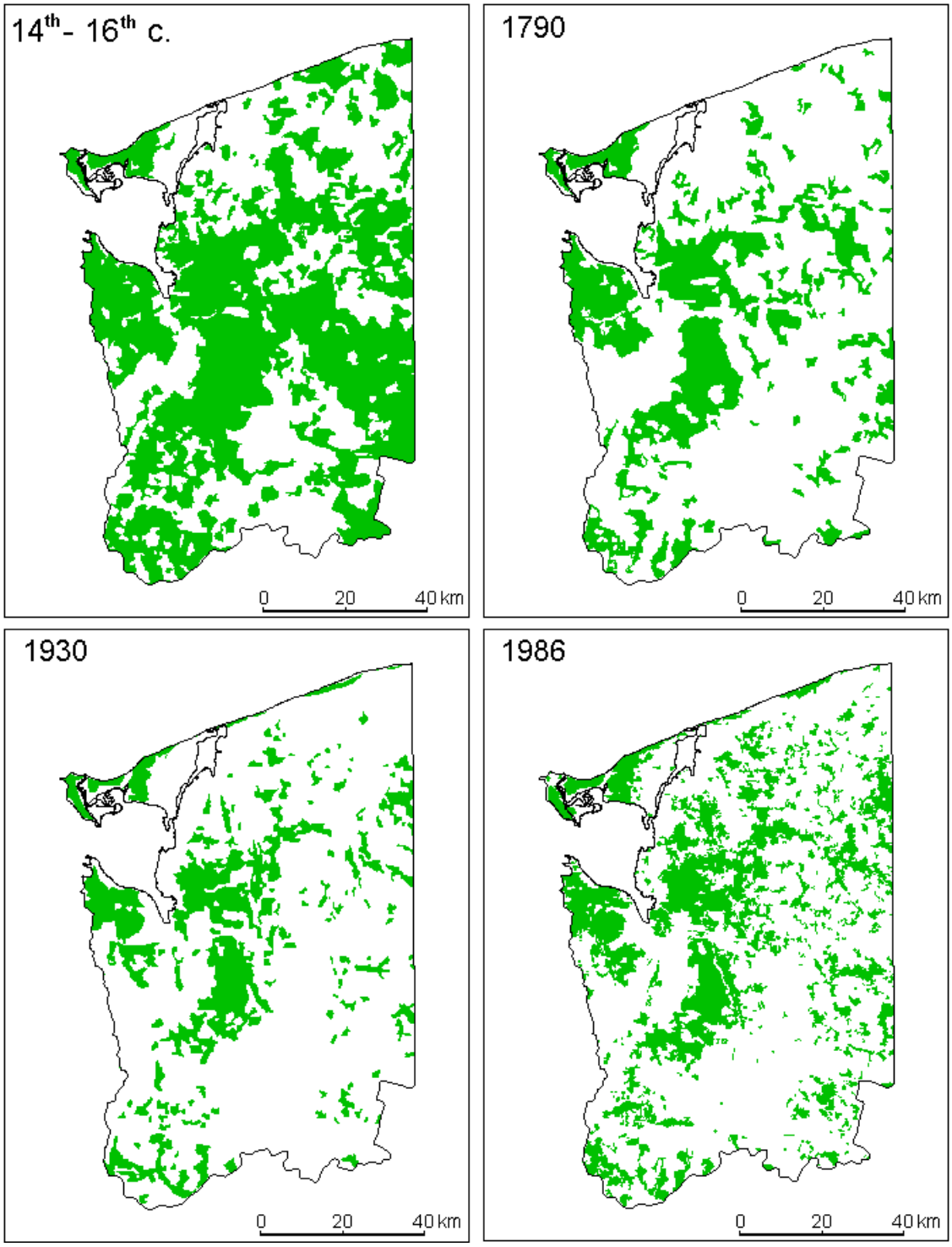
RESULTS AND DISCUSSION

Between of the 14th and 16th centuries, mainly due to agricultural settlement, forests covered about 55% of the studied area (Table 3). Compact forested areas were present only on the Wkrzańska Plain and the meso-region of Bukowe Hills (Fig.3a). In the lake region, forests covered from 60 to 75%, and the lowest percentage of forests could be found on the Pyrzyce-Stargard Plain (26%). The greatest changes were found on the Pyrzyce- Stargard Plain and the Trzebiatów Coast, the Ińsko and Choszczno Lakeland, where about 80% of the forests present in the 16th century were destroyed. On the other hand, in the meso-regions that in the 16th century had the biggest forest areas, their loss was very small, that is from 16.4% in the Bukowe Hills, to 26.5% on the Goleniów Plain. The least decrease of forested area was on the Wolin Island and Uznam Island - 7% (Fig. 3b).

Table 3. Forests area and percentage share in meso-region

Meso-region	Years							
	14th-16th c	1790	1930	1986	14th-16th c	1790	1930	1986
	(ha)				(%)			
Trzebiatów Coast	163.2	32.1	35.9	66.5	34.0	6.7	7.5	13.9
Gryfice Plain	413.1	161.5	160.5	330.8	32.3	12.6	12.5	25.8
Wkrzańska Plain	319.4	264.1	188.0	216.4	83.0	68.6	48.9	56.3
Goleniów Plain	789.4	580.8	525.0	576.5	79.7	58.6	53.0	58.2
Nowogard Plain	711.3	281.0	129.7	254.1	64.0	25.3	11.7	22.9
Ińskie Lakeland	569.4	121.1	70.5	164.3	73.6	15.7	9.1	21.3
Stargard-Pyrzyce Plain	222.9	38.6	26.3	63.6	26.0	4.5	3.1	7.4
Bukowe Hills	101.7	85.0	40.5	61.7	89.0	74.4	35.5	54.0
Lower Odra Valley	227.5	85.8	62.0	73.1	48.9	18.4	13.3	15.7
Szczecin Hills	87.4	39.9	19.7	31.7	42.5	19.4	9.6	15.4
Wełtyn Plain	284.5	114.0	92.3	112.6	60.7	24.3	19.7	24.0
Myślibórz Lakeland	173.6	113.7	88.6	96.7	65.5	42.9	33.4	36.5
Choszczno Lakeland	125.6	26.7	9.8	32.9	68.8	14.6	5.4	18.0
Łobez Upland	105.9	39.9	18.9	35.8	64.1	24.2	11.5	21.7
Wolin i Uznam	129.9	120.6	100.0	135.6	44.1	41.0	34.0	46.1
total	4424.8	2108.0	1567.8	2252.5	55.0	26.2	19.5	28.0

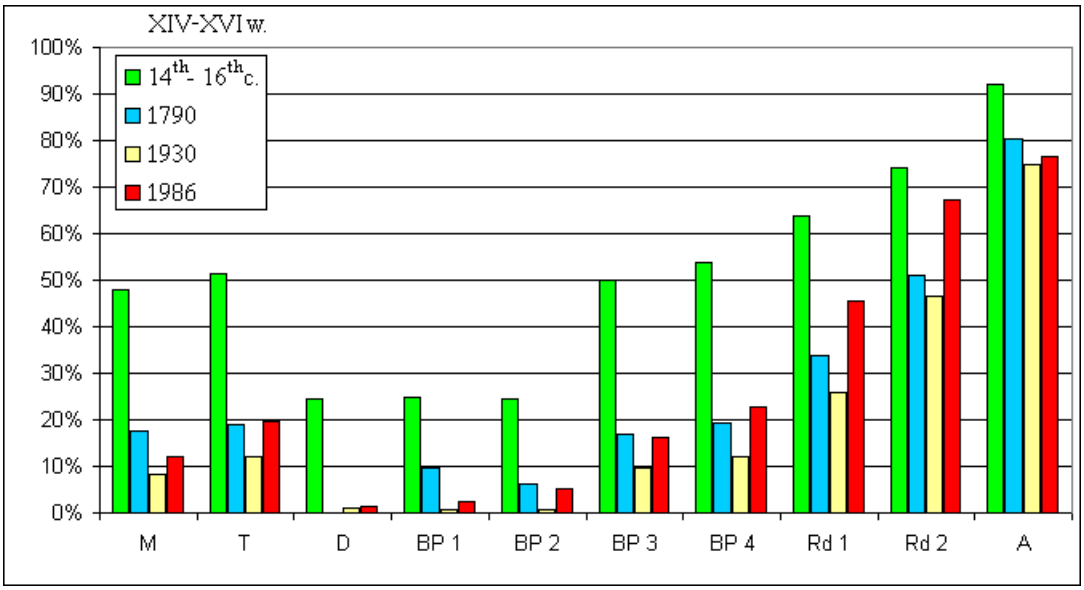
Fig. 3. Changes forested area from XIV to XX ages



Between 1790 and 1930, on the whole considered area the deforestation percentage was 25.6%, and if compared to the stand of the 16th century, it decreased by 64.6%. The time span from 1930 to 1986 was characterised by increased afforestation - from 19.5% in 1930 to 28% in 1986. The forestation thus exceeded the stand of 1970, though the forested areas were rather scattered. Similar tendencies were found in the Puszcza Kampinowska [1]. The changes described above were caused mostly by the various soil conditions in the regions. Soil conditions in the ground moraine of Szczecin Lowland were the main factor which determined the usage of land. An exception were small areas of diversified hipsometry, such as Bukowe Hills, where quite a large share of forests was found, despite the presence of fertile soils.

Analysis of forestation in connection with soil conditions has shown that as early as in medieval times the forest cover was differentiated according to the soil quality. At that time the least forests were found on soils which developed from lake silt formations, covering black earths (D), brown and lessive soils (BP1, BP2), where the forestation decreased below 25% (Fig.4). On brown and lessive soils which had developed from heavy and medium loams and loamy sands (BP3 and BP4) forests covered 50-55%, and on the poorest podzolic soils (A) forests grew on more than 90% of the area. The area of forests on water dependent soils: peat (T), muck and alluvial soils (M) were about 50%, which was the result of habitat factors, not of human activity.

Fig. 4. Changes of woodiness depending from soil cover (abbreviations explanation in chapter Material and Methods)



Soil conditions determined also the irregular decline of the forest areas during the following years. Up to the end of the 18th century the whole area of black earths (D) was taken for cultivation. On poorer brown and lessive soils remained patches of forest (7-10%). At that time forestation of areas of loamy sands (BP4) and heavy loams (BP3) decreased significantly - one half of forests that had been there in the 16th century disappeared. A similar situation was found on hydrogenic soils, which was related to extensive ameliorations in mid 19th century, the reason being their rendition to agricultural use [10]. On podzolic soils the area of forests decreased insignificantly.

From 1790 to 1930 the brown and lessive soils developed from silt (BP1) or sandy loams (BP2) had been completely deforested. On the other areas the changes were small, only several percent. An exception was the meso-region of Bukowe Hills which despite its rich soil had in 1930 about 35% of forests (Table 4). This was the result of a rich differentiation of its relief, which in turn allowed taking into agricultural use only the best soils. On brown and lessive soils of that meso-region forests grew on 25% of the area, whereas on the very same soils in the rest of the areas it did not exceed 5%.

Table 4. Forests area in meso-regions according to soil cover

Meso-region	Lata	Soil groups									
		M	T	D	BP1	BP2	BP3	BP4	Rd1	Rd2	A
		(ha)									
Wolin i Uznam	14th-16th c.	---	1742.5	---	---	29.7	---	580.2	526.3	4346.9	5738.5
	1790	---	1857.6	---	---	0.0	---	446.8	181.1	3885.7	5690.2
	1930	---	1100.6	---	---	0.0	---	311.0	39.5	3314.1	5226.8
	1990	---	1405.5	---	---	74.2	---	649.7	576.5	5045.2	5779.7
Trzebiatów Coast	14th-16th c.	1824.4	5030.6	177.2	---	5096.6	1121.4	695.3	433.8	1863.7	---
	1790	57.2	946.0	0.0	---	981.2	0.0	556.4	316.0	324.1	---
	1930	375.2	411.2	0.0	---	108.6	0.0	570.1	1.0	2121.8	---
	1990	385.0	1271.7	0.0	---	697.7	115.8	695.6	350.4	3101.9	---
Wkrzańska Plain	14th-16th c.	461.1	5448.5	---	---	90.0	---	296.8	8150.6	1144.0	16284.1
	1790	222.1	4154.5	---	---	5.0	---	184.9	6054.6	1151.0	14601.9
	1930	0.0	1493.7	---	---	0.0	---	3.0	3171.7	498.6	13628.7
	1990	70.7	1766.3	---	---	13.0	---	68.0	3860.1	1032.1	14814.0
Lower Odra Valley	14th-16th c.	320.8	14037.1	---	---	1160.2	220.1	508.9	1583.8	1657.7	3236.0
	1790	0.0	4277.7	---	---	337.0	0.0	31.0	791.9	482.0	2725.4
	1930	0.0	3837.2	---	---	226.3	0.0	0.0	339.8	287.9	1299.0
	1990	0.0	5007.9	---	---	196.5	0.0	17.0	703.4	203.3	1174.0
Goleniów Plain	14th-16th c.	4218.0	8151.6	0.0	47.6	4933.7	---	1432.9	7255.6	11658.9	41086.9
	1790	3835.7	4161.8	0.0	0.0	2023.2	---	423.1	3637.2	8165.5	35828.4
	1930	1920.3	2290.7	0.0	0.0	1893.0	---	920.1	3614.8	7842.0	33957.4
	1990	2275.6	2855.5	33.1	10.0	2069.1	---	611.3	7309.9	9288.7	33156.6
Szczecin Hills	14th-16th c.	375.2	129.9	---	---	981.7	3617.1	129.9	970.6	2537.4	---
	1790	0.0	63.9	---	---	46.2	1156.3	117.9	50.0	2557.4	---
	1930	17.0	3.0	---	---	0.0	166.9	6.0	496.1	1273.3	---
	1990	22.0	0.0	---	---	66.2	289.9	17.0	588.3	2182.7	---
Bukowe Hills	14th-16th c.	134.6	---	---	---	7455.1	---	---	1071.2	1490.0	---
	1790	238.1	---	---	---	6407.2	---	---	865.6	980.4	---
	1930	0.0	---	---	---	2852.0	---	---	739.2	449.5	---
	1990	23.1	---	---	---	4703.3	---	---	619.9	795.9	---
Wełtyn Plain	14th-16th c.	45.2	516.6	---	---	23263.0	---	---	827.9	3585.8	---
	1790	30.1	0.0	---	---	8283.7	---	---	689.9	2261.0	---
	1930	0.0	41.4	---	---	7372.6	---	---	362.9	1452.7	---
	1990	0.0	253.3	---	---	7494.0	---	---	594.6	2898.9	---
Stargard-Pyrzyce Plain	14th-16th c.	5231.4	2747.2	2085.5	935.5	8089.7	1301.9	---	1376.4	7.1	---
	1790	109.6	121.9	0.0	0.0	2656.9	95.8	---	876.4	0.0	---
	1930	0.0	163.1	0.0	0.0	1628.2	0.0	---	822.1	14.1	---
	1990	393.7	436.6	141.0	93.4	3167.1	1004.4	---	1109.9	46.3	---
Nowogard Plain	14th-16th c.	53.2	2323.8	933.2	---	27103.9	---	23117.2	14246.0	2096.9	1159.6
	1790	0.0	1088.4	12.0	---	8586.6	---	9096.8	7917.3	1097.9	296.5
	1930	0.0	364.7	120.0	---	1986.6	---	3148.9	5832.4	697.0	792.4
	1990	0.0	956.5	11.0	---	5313.5	---	7308.1	8689.2	2119.9	950.0
Gryfice Plain	14th-16th c.	0.0	7920.2	---	738.9	15385.7	---	3448.1	12031.7	1481.6	250.4
	1790	0.0	2915.4	---	664.5	4382.3	---	1132.4	6126.4	904.7	7.0
	1930	0.0	2765.3	---	58.5	3208.8	---	2507.3	5284.8	1941.5	253.3
	1990	3.9	5168.0	---	55.5	8866.3	---	4479.4	11682.2	2174.4	619.0
Myślibórz Lakeland	14th-16th c.	---	868.0	---	---	12115.9	---	---	3733.7	502.0	---
	1790	---	555.0	---	---	7072.9	---	---	3200.1	520.1	---
	1930	---	108.1	---	---	5346.4	---	---	2947.2	398.9	---
	1990	---	415.4	---	---	5795.7	---	---	2983.8	464.6	---

Table 4 cont.

Choszczno Lakeland	14th-16th c.	---	2866.7	---	---	8274.5	853.9	---	550.6	---	---
	1790	---	271.4	---	---	1869.0	526.9	---	0.0	---	---
	1930	---	49.3	---	---	938.9	0.0	---	0.0	---	---
	1990	---	436.8	---	---	2327.9	51.5	---	461.8	---	---
Ińskie Lakeland	14th-16th c.	---	5639.9	---	---	35427.3	---	7548.7	7790.7	---	---
	1790	---	657.2	---	---	8374.5	---	1404.6	1546.2	---	---
	1930	---	731.7	---	---	4241.1	---	1337.9	681.0	---	---
	1990	---	1898.6	---	---	8087.0	---	2971.1	3422.7	---	---
Łobez Upland	14th-16th c.	550.9	52.7	---	---	5195.4	---	2689.0	2091.0	---	---
	1790	321.7	70.7	---	---	1270.2	---	1258.5	1068.5	---	---
	1930	0.0	0.0	---	---	581.4	---	149.4	1158.7	---	---
	1990	142.5	129.4	---	---	1041.1	---	350.7	1907.9	---	---

The deforestation process was stopped in the 20th century, after the Second World War, which was caused by afforestation of poor and devastated land. This tendency could be seen particularly on rusty soils (RD1, RD2), where the forestation increased by about 20%, as compared to the stand of 1930. The forest area will probably further increase due to economical subsidies from the Polish State for afforestation of poorest agricultural land.

CONCLUSIONS

Analysis of forestation changes in the Szczecin Lowland, as connected with soil conditions made the following conclusions possible:

1. As early as at the turn of the 14th and l6th centuries a distinct differentiation of the Szczecin Lowland forested area, connected with the soil quality could be seen. At that time the lowest percentage of forests (below 25%) grew on soils created from lake silts and clays and sandy loams, these being black earth, brown and lessive soils. On the poorest podzolic soils the forests covered over 90% of the area.
2. During the 15th to 18th centuries the area of forests decreased significantly (from 55 to 25%). By the end of the 18th century all the area of black earths was taken for agricultural use. On brown and lessive soils of lower quality remained some small patches of forests. Sandy soils and heavy loam soils also suffered a decrease of forests, reaching 50% of the stand in the 16th century.
3. From 1790 to 1930 the brown and lessive soils developed from silt and sandy loams were completely deforested, whereas areas belonging to the other soil groups have not suffered major changes.
4. After the Second World War the forested area increased: from 19.5% up to 28% in 1986. It pertained mainly to areas of rusty soils where the forested area increased by about 20%.

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