Geographia Polonica
Volume 86, Issue 4, pp. 393–402
http://dx.doi.org/10.7163/GPol.2013.31

INSTITUTE OF GEOGRAPHY AND SPATIAL ORGANIZATION
POLISH ACADEMY OF SCIENCES
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A MAP OF SEQUENCES OF 'FOREST/NON-FOREST' STATES OVER THE LAST 200 YEARS IN THE BORDERLAND BETWEEN POLAND'S MASURIA AND KURPIE REGIONS

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Abstract

Presented here are the means of generating and possibilities for applying a digital map of sequences of 'forest/non-forest' states in a study area, as based on topographic maps for seven instances in time (between 1800 and the present day). There is also a brief description of cartographic material used, as well as the methods applied in generating a variability model. The study area was then analysed from the point of view of differences in the aforementioned sequences of 'forest/non-forest' states, this revealing marked contrasts between two Polish regions that are adjacent, but were conditioned differently in the past, in political and social terms. The study ends by considering the relationship between the distinguished sequences and habitat type, as referred to in terms of potential natural vegetation.

Key words

historical maps • changes in forest cover • potential natural vegetation • habitat variation • central Poland

A map of 'forest/non-forest' sequence states as a tool in the study of historical changes in vegetation cover

One of the main symptoms of a millennium of change in vegetation cover in Central Europe induced by human activity is the conversion of forest into arable fields. However, this process is not quite as straightforward and unidirectional as it appears, since deforestation has gone hand in hand with the reverse process entailing the reforestation of farmland. 'Forest/non-forest' changes of state are most often the result of changes in population or forms of ownership, as well as – for a hundred years and more now – the consequence of evolution in demand for land.

A part of Poland in which recently-deforested areas occur side by side with many secondary forests on former farmland is the large glacial outwash plain straddling the border between the regions known as Masuria and Kurpie. While these do not now coincide very well with high-level administrative divisions of Poland, there was for a century here a boundary in both ethnic and political terms. This former borderland is there-

fore a suitable model area for multifaceted, comprehensive research carrying out to better understand the directions, forms and rates assumed by processes of the regeneration of post-agricultural forest communities (Matuszkiewicz et al. 2013ab), as well as to determine the influence of the natural environment, as well as political and social conditioning, on the process of historical change affecting the field-forest landscape (Matuszkiewicz et al. 2014). A map of distinguished sequences formed a basic tool in this research encompassing both spatial differences and spatial changes in vegetation cover.

This study seeks to present the means by which a digital map of the aforementioned sequences of 'forest/non-forest' states was generated, along with certain possibilities for this map – or maps of this kind – to be made effective use of. In this regard, it is worth emphasising that maps of vegetation (including of forest cover), on which the historical situation is set against the contemporary one are absolutely nothing new. However, while they have indeed been created with the aid of GIS techniques for some ten years now (Kowalska 2009; Orczewska 2009), a rather new aspect of the work described here relates to the number of instances in time it has sought to take into account. In this way a better understanding can be gained, not only of initial and final (most recent) states, but also of what may be a whole sequence of intermediate states. Once the latter are recognised, there are further possibilities for quantitative and qualitative analysis of changes in forest cover, as well as differences in these changes noted from place to place over the last 200 years.

Materials and methods used in drawing up the sequence map

A needs analysis was first carried out, taking into account the scope of the subject matter, as well as the work's spatial and temporal framework, this revealing that there was no possibility of creating the kind of homogeneous map that would meet requirements regarding comparability of scale[1]. It was therefore accepted, following an analysis of existing cartographic sources, that materials suitable for processing would be on two series of scales: from 1:25,000 to 1:100,000 (20th century) and from 1:50,000 to 1:200,000 (19th century).

A first stage then entailed the assessment of the usefulness of collected medium-scale topographic maps covering the entire study area or its two parts separately (where the 19th century was concerned). Account was taken of those features of maps attesting to their quality, i.e. accuracy, cartometric features, faithfulness, completeness, legibility, relevance and originality of source material. Assessment of usefulness was based first and foremost on detailed literature studies, and took in both the maps themselves (mathematical bases, course and precision of topographic work, means of printing, degree to which successive editions were updated, and so on) and the times in which they were created, including in relation maps purpose that might have influenced their content, differences in measuring systems, linguistic issues as regards nomenclature, etc. The maps selected for further analysis were divided into two groups, as principal[2] and supplementary[3]. Table 1 presents part of the material used from seven instances in time (1800, 1830, 1885, 1928, 1950, 1970 and 2000).

Further stages entailed: the scanning of materials obtained in analogue form, the analysis and selection of an appropriate method for the digital representation of spatial data, calibration and the registration of raster images (155 sheets deriving from 15 map series), as well as the identification and selection of common categories and objects at all instances in time, vectorisation, planning and later standardisation of databases, as well as graphic and conceptual generalisation (Wolski 2012). The last stage was to implement an appropriate model for change sequences in relation to forest cover along the border between Masuria and Kurpie in the last 200 years. A final map comprising more than 23,000 polygons arose out an intersection of seven states dealing with the forest cover present at different times, albeit with

[1] This fact, i.e. manifesting itself via the influence of graphic and conceptual generalisation on differences in numbers, shapes, areas and categories, and sometimes even locations of objects, was taken account of in successive stages to the development of the model for changes in forest cover.

[2] Those maps that constitute an information base for the different instances in time and were components in the model for changes in forest cover (being subject to raster calibration and vectorisation).

[3] Those maps that constitute sources of information serving solely in the verification (supplement or correction) process, and not being component elements in the model for change in forest cover (only being subject to the raster calibration procedure).

Table 1. Cartographic materials used for preparing map of sequences of 'forest/non-forest' states.

Approximate date	Name of the map	Scale	Scope of the map
1800	*Topographisch-Militärische Karte vom vormaligen Neu Ostpreussen, oder dem jetzigen Nördlichen Theil des Herzogthums Warschau, nebst dem Russischen Distrikt*	1:150,000	south part (Kurpie)
	Karte von den Provinzen Litthauen, Ost- und West-Preussen u. d. Netz-Distrikte	1:50,000	north part (Masuria)
	Karte von Ost-Preussen nebst Preussisch Litthauen und West-Preussen nebst dem Netzdistrict	1:150,000	north part (Masuria)
1830	*Topographische Specialkarte des Preussischen Staats und der angrenzenden Länder*	1:200,000	the whole area
1885	*Topographische Karte vom Preussischen Staate unter Einschluss der Anhaltinischen und Thüringischen Länder*	1:100,000	north part (Masuria)
	Novaya Topograficheskaya Karta Zapadnoy Rossii	1:84,000	south part (Kurpie)
1928	*Messtischblätter*	1:25,000	almost the whole area, except a part of Kurpie
	Military Institute of Geography tactical map	1:100,000	a part of Kurpie region
1950	Topographic map in "Borowa Góra" reference system	1:100,000	the whole area
1970	Topographic map in "1965" reference system	1:25,000	the whole area
2000	VMap Level2 – vector reference map	1:50,000	the whole area

the extent of forests at any given instance being reduced to a basic 'forest' (F) or 'non-forest' (n) dichotomy.

Analysis of the sequence map

Procedure in line with the methodological assumptions described above led to the conclusion that there were 128 possible change sequences, of which 122 were observed to have taken place in reality. Among these, 43 sequences were selected as of the greatest significance, since they were capable of characterising almost 99% of the study area (Tab. 2). All sequences actually noted could then be assigned to just six groups, of which two entailed a single element, i.e. persistent presence or absence of forest throughout the entire period. That left four groups identified on the basis of information on the initial and final states as regards the existence of forest in 1800 and 2000 respectively. A further, separate, category accounts for the absence of forests in line with the presence of lakes (Fig. 1).

The following statements are justified in the light of analysis of the material compiled:

– Areas not undergoing a change of state over the last 200 years account for some 52.6% of Masuria and 54.2% of Kurpie. However, despite this superficial similarity, the regions are actually seen to differ fundamentally in that, in Masuria, permanent forests have occupied only slightly less land than persistently non-forest areas (22% as opposed to 29%), whereas in Kurpie the respective figures are 15% and 40%.
– Permanent forest are only present in the interfluves of the largest rivers, while areas permanently deforested are concentrated in river valleys above all.
– Land characterised by a shorter or longer period of deforestation accounts for around 6% of the area (mainly in the interfluves) – similarly in both regions within the overall study area. There is also a prevalence of land deforested in the second half of the 19th or first half of the 20th centuries, i.e. "the period of great transformations".
– Areas that were deforested in 1800 but are now under forest cover account for around 32% of Masuria, but only for around 10% of Kurpie. In the northern part of the study area, the most widespread kind of area is that which was afforested in the second half of the 20th century (pre-1970), as well as in the late 19th and early 20th centuries and in the mid 19th

Table 2. Sequences of 'forest/non-forest' changes in the present-day forests area.

Sequence - forest (F), non-forest (n)							Description	Area and share of the sequence					
								Masuria		Kurpie		Total	
1800	1830	1885	1928	1950	1970	2000		km²	%	km²	%	km²	%
F	F	F	F	F	F	F	always forest	342.6	21.77	184.2	14.46	526.2	18.50
n	F	F	F	F	F	F	afforested 1830	7.5	0.48	3.5	0.27	11.0	0.39
n	n	F	F	F	F	F	afforested 1885	91.3	5.80	52.6	4.13	143.6	5.05
n	n	F	n	F	F	F	afforested 1885 (excl. 1928)	3.1	0.19	4.3	0.33	7.3	0.26
n	n	F	n	n	F	F	afforested 1885 (excl. 1928-1950)	10.7	0.68	9.3	0.73	19.9	0.70
n	n	F	F	n	F	F	afforested 1885 (excl. 1950)	3.2	0.20	2.7	0.21	5.9	0.21
n	n	n	F	n	F	F	afforested 1928 (excl. 1950)	5.9	0.37	0.9	0.07	6.8	0.24
n	n	n	F	F	F	F	afforested 1928	130.3	8.28	8.2	0.64	138.5	4.87
n	n	n	n	F	F	F	afforested 1950	26.7	1.70	4.3	0.33	31.0	1.09
n	n	n	n	n	F	F	afforested 1970	184.9	11.75	32.7	2.56	217.2	7.64
n	n	n	n	n	n	F	afforested 2000	32.8	2.08	9.6	0.76	42.4	1.49
n	?	?	?	?	?	F	total afforested	502.5	31.93	131.6	10.33	634.1	22.27
F	n	F	F	F	F	F	forest, only deforested 1830	1.0	0.06	0.7	0.06	1.7	0.06
F	n	n	n	n	F	F	forest, only deforested 1830-1950	3.7	0.23	0.7	0.05	4.4	0.15
F	F	n	F	F	F	F	forest, only deforested 1885	25.2	1.60	11.9	0.94	37.1	1.31
F	F	n	n	F	F	F	forest, only deforested 1885-1928	5.2	0.33	7.7	0.61	12.9	0.45
F	F	n	n	n	F	F	forest, only deforested 1885-1950	34.2	2.17	20.7	1.62	54.8	1.93
F	F	n	n	n	n	F	forest, only deforested 1885-1970	6.4	0.41	5.4	0.42	11.8	0.41
F	F	F	n	n	n	F	forest, only deforested 1928-1970	1.2	0.07	1.5	0.12	2.7	0.09
F	F	F	n	F	F	F	forest, only deforested 1928	2.1	0.14	13.7	1.07	15.8	0.56
F	F	F	n	n	F	F	forest, only deforested 1928-1950	8.2	0.52	9.0	0.71	17.2	0.61
F	F	F	F	n	F	F	forest, only deforested 1950	1.3	0.08	4.3	0.34	5.6	0.20
F	F	F	F	F	n	F	forest, only deforested 1970	0.7	0.04	1.1	0.08	1.8	0.06
F	?	?	?	?	?	F	total - forests temporarily deforested	92.4	5.87	80.1	6.29	172.5	6.06
n	F	n	n	n	n	n	forest only 1830	9.3	0.59	2.4	0.19	11.7	0.41
n	F	F	n	n	n	n	forest only 1830-1885	0.5	0.03	0.9	0.07	1.4	0.05
n	n	F	n	n	n	n	forest only 1885	5.1	0.32	20.3	1.59	25.3	0.89
n	n	F	F	n	n	n	forest only 1885-1928	0.1	0.01	2.5	0.19	2.6	0.09
n	n	n	F	n	n	n	forest only 1928	1.7	0.11	0.9	0.07	2.6	0.09
n	n	F	F	F	n	n	forest only 1885-1950	0.7	0.05	4.4	0.34	5.1	0.18
n	n	F	F	F	F	n	forest only 1885-1970	1.7	0.11	2.1	0.17	3.9	0.14
n	n	n	F	F	F	n	forest only 1928-1970	1.4	0.09	0.5	0.04	1.8	0.06
n	n	n	F	F	n	n	forest only 1928-1950	2.0	0.13	0.6	0.05	2.6	0.09
n	n	n	n	F	n	n	forest only 1950	0.8	0.05	1.5	0.11	2.2	0.08
n	n	n	n	n	F	n	forest only 1970	6.7	0.43	3.7	0.29	10.4	0.37
n	?	?	?	?	?	n	total - temporary forests	31.6	2.01	42.4	3.33	74.0	2.60
F	n	n	n	n	n	n	deforested 1830	12.9	0.82	36.0	2.83	48.9	1.72
F	F	n	n	n	n	n	deforested 1885	84.6	5.37	235.0	18.45	318.7	11.21
F	F	n	n	F	n	n	deforested 1885 (excl. 1950)	0.4	0.03	3.0	0.24	3.5	0.12
F	F	n	n	n	F	n	deforested 1885 (excl. 1970)	1.6	0.10	2.1	0.16	3.7	0.13
F	F	F	n	n	n	n	deforested 1928	7.6	0.48	31.8	2.50	39.4	1.39
F	F	F	n	F	n	n	deforested 1928 (excl. 1950)	0.1	0.01	4.6	0.36	4.7	0.16
F	F	F	F	n	n	n	deforested 1950	0.1	0.01	2.7	0.21	2.9	0.10
F	F	F	F	F	n	n	deforested 1970	0.9	0.06	4.1	0.32	5.0	0.18
F	F	F	F	F	F	n	deforested 2000	7.7	0.49	3.7	0.29	11.4	0.40
F	?	?	?	?	?	n	total - deforested area	119.1	7.57	329.4	25.86	448.5	15.75
n	n	n	n	n	n	n	lakes	33.9	2.15	0.2	0.02	34.1	1.20
n	n	n	n	n	n	n	never forest	451.9	28.71	505.8	39.71	956.2	33.58

Note: 43 sequences of 128 possible and 122 recorded are presented; 'total' consists also of the sequences not presented, but belonging to the type.

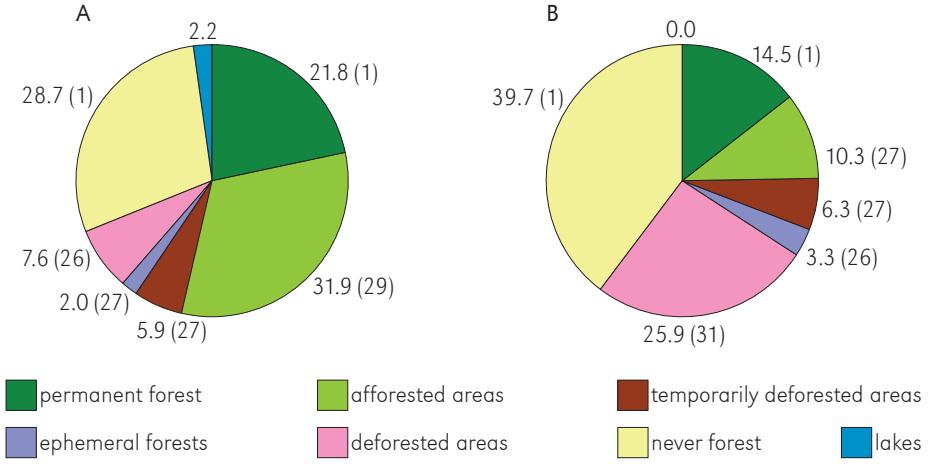

Figure 1. The typology of the sequences of 'forest/non-forest' states – the spatial share of distinguished groups and number of the sequences (in parentheses). A – Masuria, B – Kurpie.

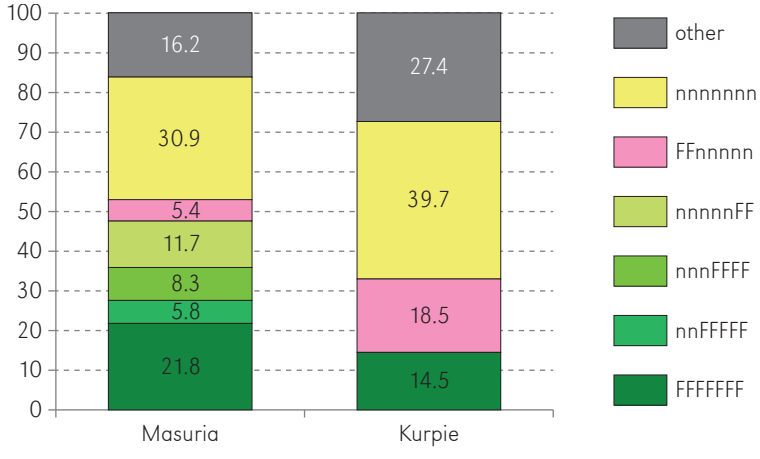

Figure 2. The spatial share of the most frequent (above 5%) sequences of 'forest/non-forest' states.

century. In Kurpie, in contrast, the highest level of afforestation characterised the mid 19th century, as well as the 1950s and 60s.

– The phenomenon of non-forest areas undergoing transitional episodes of afforestation is not very widespread (accounting for just around 2-3% of the area), with patches widely scattered. Relatively the most frequent is the sequence *nnFnnnn* (i.e. afforestation in the second half of the 19th century).
– Land deforested throughout the period (having been under forest cover in 1800, but deforested in 2000) covers only limited areas in Masuria (less than 8%), but is very extensive in Kurpie (almost 26% of the total). The main deforestation activity in the north took place in the mid 19th century, while in Kurpie this had occurred several decades earlier. It is also possible to identify far less extensive areas that were cleared at the end of the 19th century and early 20th century.

In analysing the area occupied by the most frequent 'forest/non-forest' sequences (Fig. 2), i.e. those having a more than 5% share, it is possible to note several trends by which a marked distinction can be drawn between the two regions, i.e.:

– a higher proportion of sequences featuring persistence of forest cover in Masuria, as well as persistence of the deforested state in Kurpie,
– in Masuria, a large proportion of sequences in which forest appeared after 1885, 1928 or 1970,

– in Kurpie, a much higher proportion of sequences entailing deforestation post 1885,
– a greater mosaic (i.e. share of rare sequences) in Kurpie.

Regional variability in sequences of 'forest/non-forest' states as set against overall changes in forest cover

The data obtained allowed three periods to be identified where changes in forest cover were concerned (Fig. 3):

– the first half of the 19th century – rather stable forest cover (at around 40%), albeit with a slight downward trend,
– the period between the mid 19th and mid 20th centuries characterised by more limited forest cover (initially down to around 30%), but then manifesting a steady renewed increase,
– the period from the mid 20th century onwards with rather stable forest cover (at around 46%), albeit with a slight upward trend.

For a full portrayal of the situation, changes in afforestation need also to be looked at from the perspective of each historical region separately (Fig. 4).

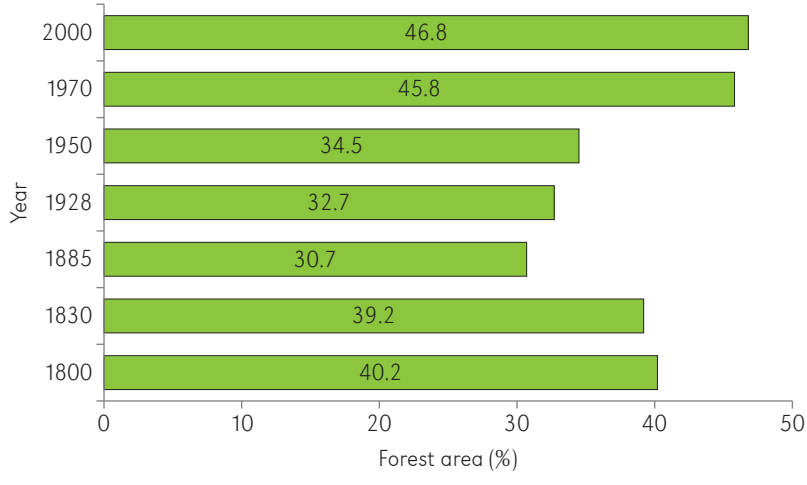

Figure 3. Afforestations in the study area between 1800 and 2000.

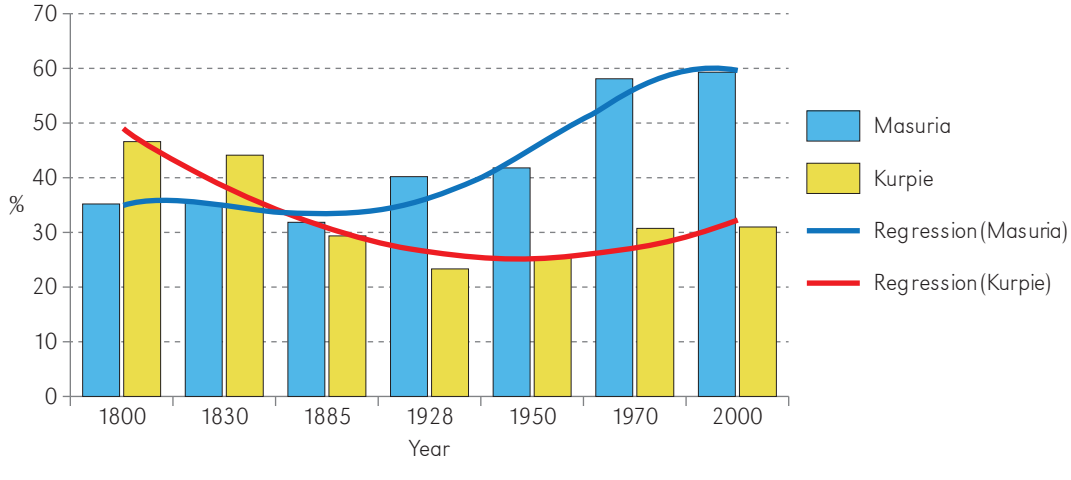

Figure 4. Afforestations in the northern (Masuria) and southern (Kurpie) parts in 1800-2000.

Regression (Masuria): $y = -0.2111x^4 + 3.138x^3 - 14.293x^2 + 23.999x + 22.524$; $R^2 = 0.9559$
Regression (Kurpie): $y = 1.5506x^2 - 15.174x + 62.624$; $R^2 = 0.8647$

At the beginning of the 19th century, the level of afforestation in the southern part (Kurpie) was markedly (more than 10%) greater than in the northern. However, the mid 19th century saw forest cover decline across the area, though much more in the south than the north. As a result of this, the relationship that had pertained previously reversed, with the level of forest cover in Masuria now being more than 28% greater than in Kurpie. However, the minimum level of forest cover in the latter region characterised the first half of the 20th century, and the period since has brought a slow but sure rise, albeit not yet to such an extent that we have reverted to the 1800 situation. In comparison with that time there is a still a net loss of 16% over the period as a whole. In contrast, in Masuria, forest cover was never lower than in the mid 19th century, with two waves of reforestation taking place after that – in the late 19th/early 20th centuries and in the second half of the 20th century. The overall effect of this across the whole period has been for forest cover to be up by 24%.

In summing up the above considerations, it is possible to note the following phenomena:
– periodicity – similar initial states, profound transformations in the 19th century and first half of the 20th, and then a stabilisation of the two states in the most modern times,
– a divergence of the regions, in the sense of ever-more marked differences in the level of development in Kurpie and Masuria,
– asynchronicity to changes in the two regions.

The relationship between sequences of 'forest/non-forest' states and habitat variability

A comparison between the map of sequences of 'forest/non-forest' states and the map of potential natural vegetation allows for the tracing of any differences in trends for forest cover over the last 200 years relating to habitat type, and separately for Masuria (Fig. 5A) and Kurpie (Fig. 5B).

The most important regularities revealed in this way should be taken to involve either the habitats of limited attractiveness where agriculture is concerned (on account of their being oligotrophic or hard to use for other reasons), or those attractive when it comes to farming (on account of their being eutrophic)[4]. The shares of almost all the sequence types differ in relation to these groups. Two centuries ago the unattractive habitats were mostly still under forest, and that circumstance has continued to prevail throughout the period under study. On the other hand, the habitats tempting for farmers were already being deforested to a marked degree by the beginning of the 19th century, and that processed continued for a further 150 years. Only in the last half-century have local (only) trends towards the reforestation of these areas begun to make themselves apparent.

What is also clear is the marked tendency for change to involve identifiable periods – of intensified afforestation or deforestation, the result of these being defined sequences of various extents.

In the case of Masuria, it is possible to identify the following periods:
– The early 19th century (1800-1830) – in which only limited (1-2.8%) deforestation of eutrophic habitats took place.
– The mid 19th century (1830-1885) – during which there was marked, more permanent deforestation of eutrophic and moist habitats (*Fraxino-Alnetum*, *Tilio-Carpinetum stachyetosum* and *Ribeso-Alnetum*), as well as more limited impacts on fresh eutrophic habitats (*Tilio-Carpinetum typicum*, *Tilio-Carpinetum calamagrostietosum*) and moist mesotrophic habitats (*Querco-Pinetum molinietosum*). At the same time, a process of more permanent afforestation of oligotrophic and mesotrophic habitats got underway. This respectively took in some 21.9, 6.1 and 4.1% of the *Peucedano-Pinetum*, *Querco-Pinetum typicum* and *Querco-Pinetum molinietosum* habitats.
– The late 19th and early 20th centuries (1885-1928), during which there was an intensification of afforestation work in poorer habitats, encompassing 27.4% of *Peucedano-Pinetum* habitat, as well as 11.1 and 4.7% respectively of the *Querco-Pinetum* and *Querco-Pinetum molinietosum* habitats. The process weakened rather, but was still taking place, in the first half of the 20th century.

[4] The unattractive habitats comprise those of: pine forest (*Peucedano-Pinetum*), moist pine forest (*Molinio-Pinetum*), mixed oak-pine forest (*Querco-Pinetum*) and alder carrs (*Ribeso-Alnetum*), while the attractive ones are of ash-alder alluvial forest (*Fraxino-Alnetum*) and lime-oak-hornbeam forest (*Tilio-Carpinetum*).

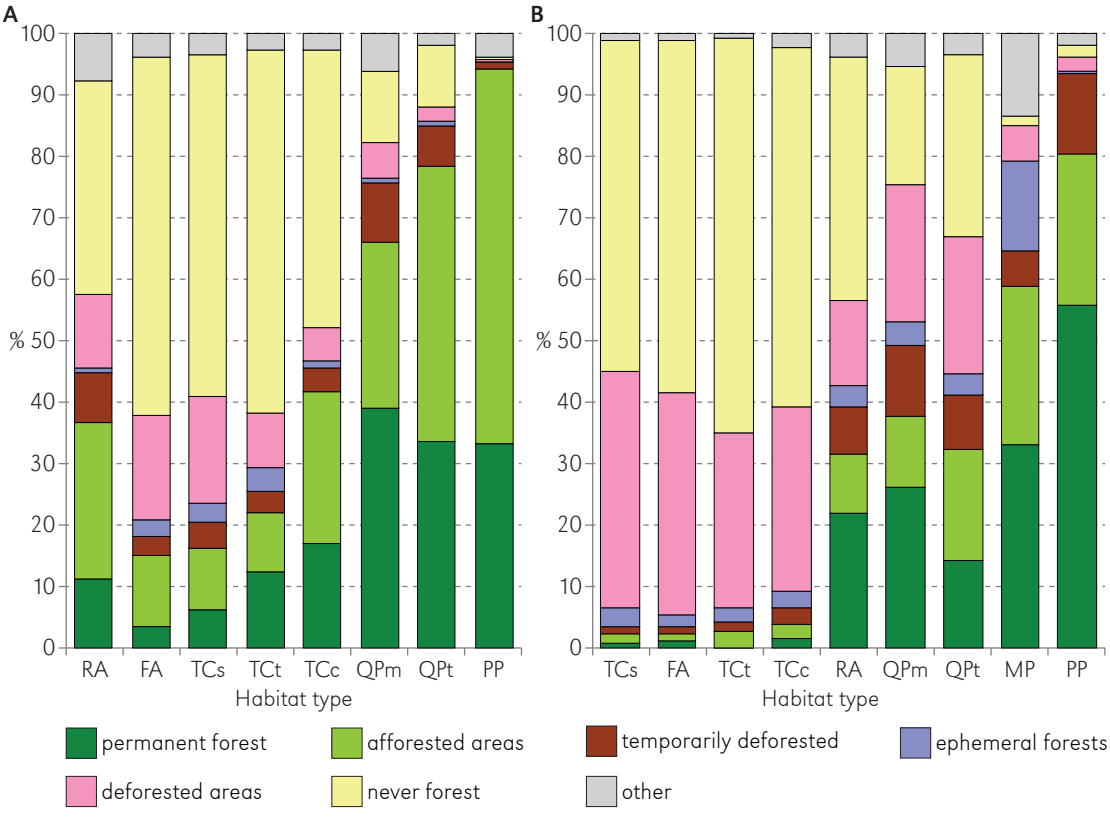

Figure 5. Selected groups of sequences 'forest/non-forest' in the main types of habitats determinated by potential natural vegetation. A – Masuria, B – Kurpie.

Note: FA – *Fraxino-Alnetum*, MP – *Molinio-Pinetum*, PP – *Peucedano-Pinetum*, QPm – *Querco-Pinetum molinietosum*, QPt – *Querco-Pinetum typicum*, RA – *Ribeso-Alnetum*, TCc – *Tilio-Carpinetum calamagrosyietosum*, TCs – *Tilio-Carpinetum stachyetosum*, TCt – *Tilio-Carpinetum typicum*.

– The second half of the 20th century (1950-1970), during which afforestation first and foremost took in mesotrophic habitats (*Querco-Pinetum typicum, Querco-Pinetum molinietosum*, *Ribeso-Alnetum*), or else weakly eutrophic ones (*Tilio-Carpinetum calamagrostietosum*). Only to a lesser extent were highly eutrophic habitats like *Fraxino-Alnetum*, *Tilio-Carpinetum typicum* and *stachyetosum* involved, as well as some of the oligotrophic ones (*Peucedano-Pinetum*). This trend continued in the years 1970-2000, though the scope of the afforestation work was more limited.

A feature of interest is the identification within Masuria of sequence that entailed the ephemeral appearance of forest in eutrophic habitats around 1830. It is not possible to preclude the presence of forest at this time being a consequence of the depopulation occurring in East Prussia in the aftermath of the Napoleonic Wars.

In turn, in the case of Kurpie, four periods of change can be identified, i.e.:

1. At the beginning of the 19th century (between 1800 and 1830) – a permanent, if really limited deforestation of the most eutrophic habitats, i.e. moist lime-oak-hornbeam forests (*Tilio-Carpinetum stachyetosum*) and ash-alder alluvial forests (*Fraxino-Alnetum*).
2. In the mid 19th century (1830-1885) – a very major – and permanent – deforestation of all eutrophic habitats (*Tilio-Carpinetum* and *Fraxino-Alnetum*), as well as a less-marked trend noted for mesotrophic sites, and a local trend for oligotrophic sites featuring fresh or moist pine forest. At the same time there was a more-permanent reforestation of highly-oligotrophic

fresh pine forest (*Peucedano-Pinetum*) habitats, as well as those of moist pine forest (*Molinio-Pinetum*). There was also a limited reappearance of forest involving around 5% of mesotrophic habitats. This is undoubtedly the period across the two centuries that was associated with the most marked changes in forest cover.

3. In the late 19th and early 20th centuries (the 1885-1928 period) – a limited though persistent deforestation in some (around 2-5%) mesotrophic and eutrophic habitats.
4. In the second half of the 20th century (years 1950-1970) – a limited, persistent reforestation in mixed oak-pine and fresh pine habitats (*Querco-Pinetum typicum* and *Peucedano-Pinetum*). At the same time, deforestation affected more than 14% of the moist pine forest (*Molinio-Pinetum*) habitat, which had been subject to transitional reforestation from the beginning of the 19th century onwards.

Also noteworthy are differences between the regions entailing partial asynchronicity to changes of forest landscape regarding the rate of reforestation in different types of habitat. There was marked deforestation of eutrophic habitats in both regions in the years 1830-1885. However, while this process had wound down in Masuria by the turn of the century, in Kurpie it was still ongoing, if at lesser intensity. There were also different timings to the change in attractiveness to farmers of oligotrophic and mesotrophic (*Peucedano-Pinetum* and *Querco-Pinetum*) habitats. The beginning of the 20th century witnessed far greater agricultural use being made of oligotrophic habitats (especially pine forests) in Masuria than in Kurpie.

By around 1800, the level of deforestation of *Peucedano-Pinetum* habitats stood at 62% in Masuria, compared with just 28% in Kurpie, while the respective figures for *Querco-Pinetum typicum* were 57% and 53%. However, there was then (by the mid 19th century) a large-scale and intensive process of afforestation in Masuria. In contrast, in Kurpie, mesotrophic *Querco-Pinetum* habitats remained attractive to farmers in the early 20th century and so were still experiencing deforestation. It was only in the second half of the last century that this trend changed.

In the light of these considerations, it can be suggested in summary that, where changes in forest cover in relation to given habitat types are concerned, Kurpie was around 50-100 years 'behind' Masuria.

Conclusions

The process described here – by which a model for sequences of 'forest/non-forest' states was constructed and then used – has allowed several methodological conclusions to be formulated. This is to say that there is no doubt that a cartographic depiction of this kind:

1. represents a valuable source of information regarding changes in the landscape and their rates, as these concern forest as a key element of vegetation cover,
2. allows for the reporting of large-scale differences in chronologies to changes, on particular areas of land, as well as in the regions concerned as a whole,
3. entails a large margin of uncertainty associated with the use of historical maps (especially those from the first half of the 19th century), and requires the devising of a strict procedure taking into account errors at almost every stage of data-processing.

Editors' note:
Unless otherwise stated, the sources of tables and figures are the author(s), on the basis of their own research.

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Article first received • October 2013
Article accepted • December 2013

MAP OF SEQUENCES OF 'FOREST - NON-FOREST' STATES OF THE BORDERLAND OF MASURIA AND KURPIE WITHIN THE LAST 200 YEARS

Jan Marek Matuszkiewicz
Jacek Wolski
Anna Kowalska

0 5 10 km

Study area

Historical border (1800)

District town

Afforested areas

FFFFFFF
nFFFFFF
nnFFFFF
nnFnFFF
nnFnnFF
nnFFnFF
nnnFnFF
nnnFFFF
nnnnFFF
nnnnnFF
nnnnnnF

Temporarily afforested areas

nFnnnnn
nFFnnnn
nnFnnnn
nnFFnnn
nnnFnnn
nnFFFnn
nnnFFFn
nnnFFnn
nnnnFnn
nnnnnFn

Deforested areas

nnnnnnn
Fnnnnnn
FFnnnnn
FFnnFnn
FFnnnFn
FFFnnnn
FFFnFnn
FFFFnnn
FFFFFnn
FFFFFFn

Temporarily deforested areas

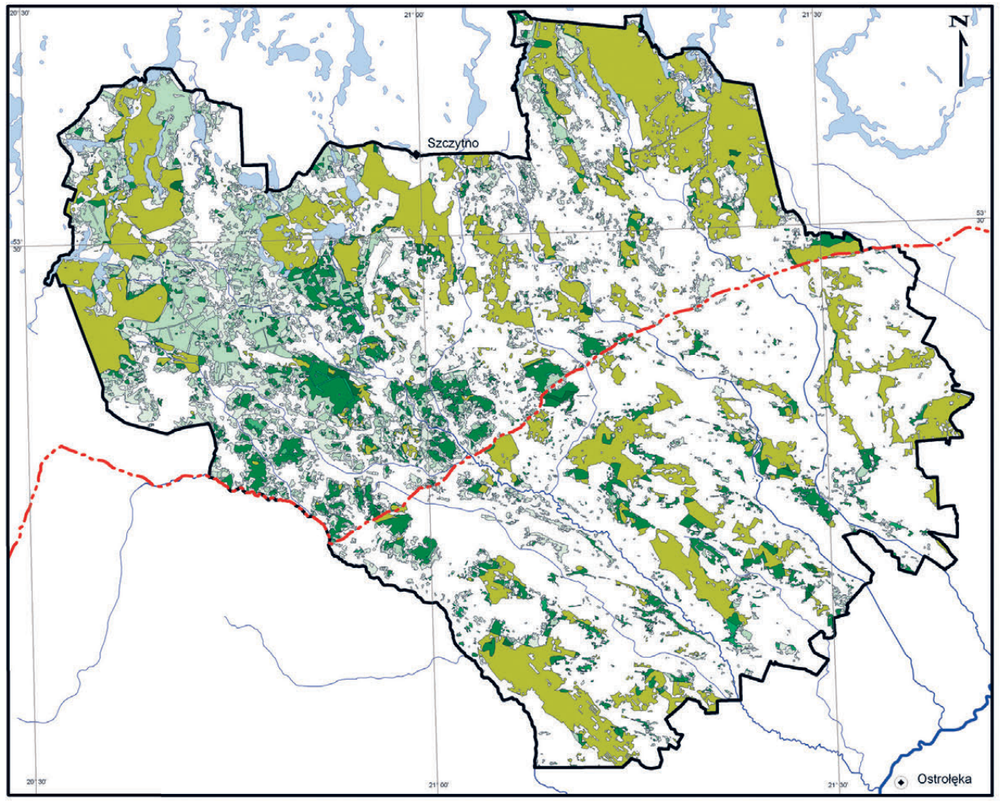
FnFFFFF
FnnnnFF
FFnFFFF
FFnnFFF
FFnnnFF
FFnnnnF
FFFnnnF
FFFnFFF
FFFnnFF
FFFFnFF
FFFFFnF

Explanation of sequences codes in Table 1

Part of study area at a scale of 1:10,000

Location of study area

INSTITUTE OF GEOGRAPHY AND SPATIAL ORGANIZATION
POLISH ACADEMY OF SCIENCES
www.igipz.pan.pl



Afforested areas

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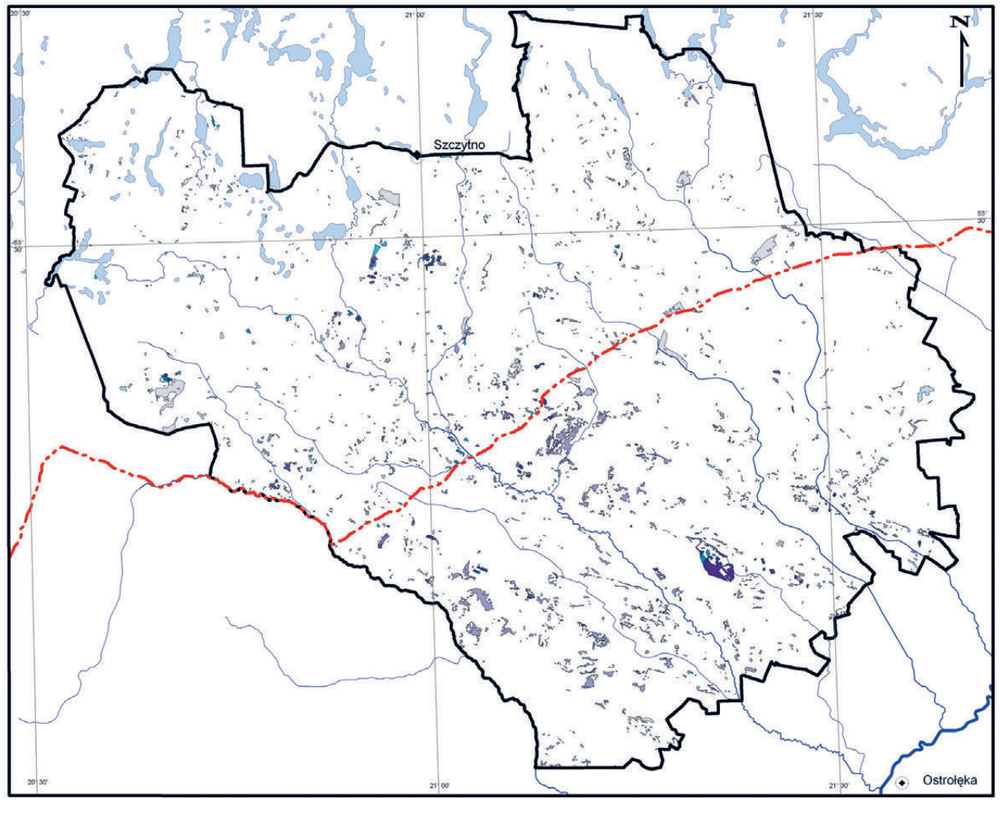
nnnFnFF
nnnFFFF
nnnnFFF
nnnnnFF
nnnnnnF



Temporarily afforested areas

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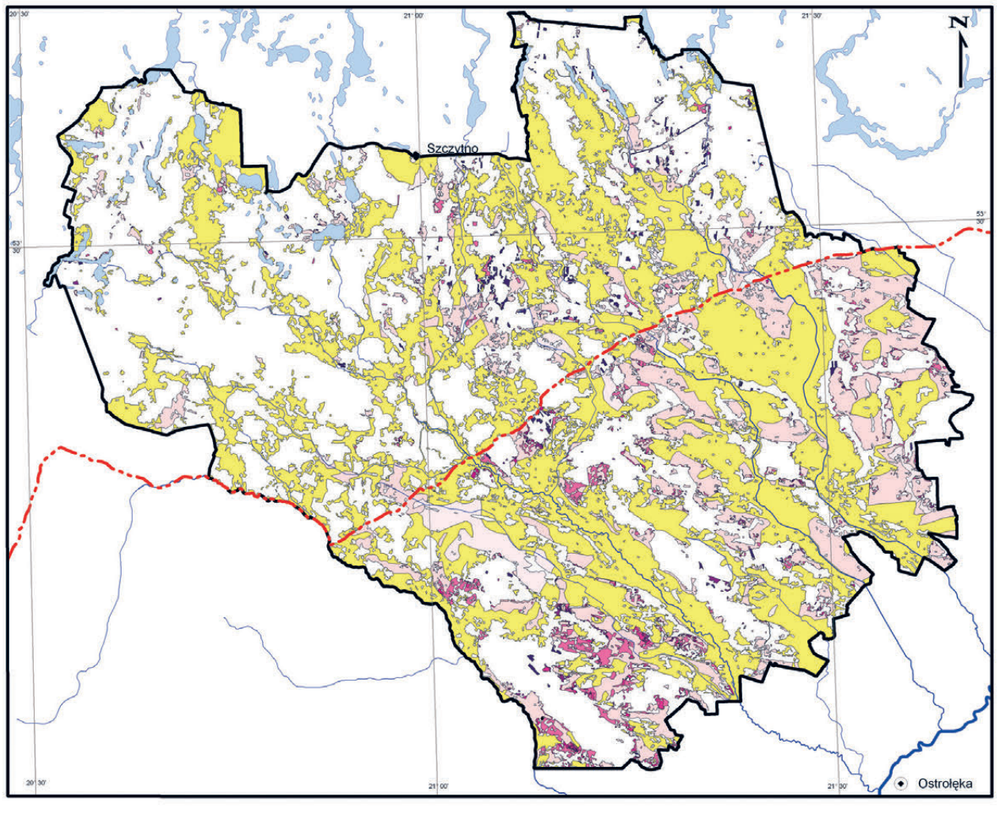

Deforested area

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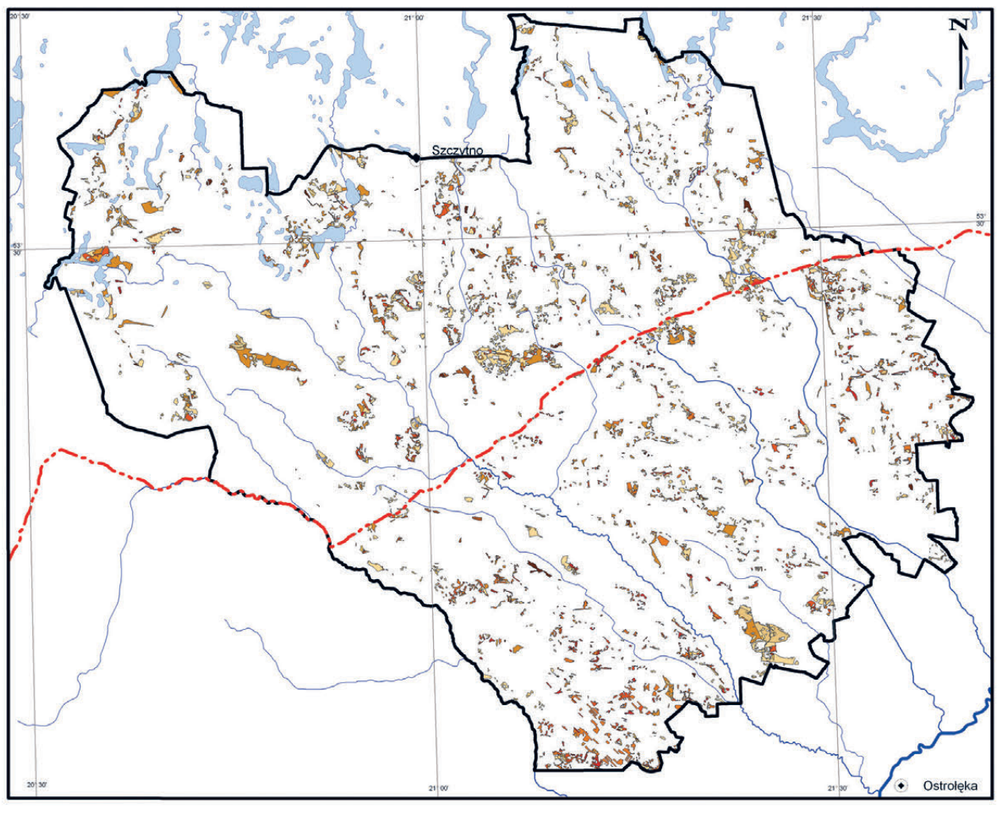
FFFnnnn
FFFnFnn
FFFFnnn
FFFFFnn
FFFFFFn



Temporarily deforested areas

FnFFFFF
FnnnnFF
FFnFFFF
FFnnFFF
FFnnnFF
FFnnnnF
FFFnnnF
FFFnFFF
FFFnnFF
FFFFnFF
FFFFFnF