

A stylized black and white graphic of a globe, showing the continents of Europe and Africa. The globe is partially obscured by the text 'STUDIA GEOHISTORICA'.

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## ***Contents***

*A note from the editors* ..... 5

### *International Conference of Historical Geographers*

**Diogo de Carvalho Cabral**

Landscape and Letterscape in Early Colonial Brazil ..... 7

**Karen M. Morin**

Prisoners and Animals: An Historical Carceral Geography ..... 28

**Humphrey Southall**

Spaces, Places, Features and Units: Web-Enabling Historical Geography ..... 39

### *Articles and theses*

**Agnieszka Latocha, Dominik Nowakowski**

Sources and Methods Used in the Reconstruction of Settlement Networks:  
An Archaeological and Geographical Perspective on the Example of Silesia ..... 55

**Marek Sobczyński**

Polish Geographical Survey of Borders until 1945 ..... 70

**Roman Czaja**

Historical Atlas of Polish Towns. Between Source Edition  
and the Cartographic Presentation of Research on the History of Towns ..... 80

**Piotr Guzowski**

Economic Geography of Poland in the Period of Growth (14–16th Century)  
in the Polish Historical Study ..... 90

**Dzmitry Vitsko**

Historical Cartography in Belarus (Studies on the Administrative Division,  
Borders and Population of the Grand Duchy of Lithuania) ..... 110

**Henryk Rutkowski**

A Few Comments on the Historical Borders in Poland ..... 124

**Bogumił Szady**

Historical Cartography of Confessions and Religions in the Polish-Lithuanian  
Commonwealth: Between Historical Geography and Spatial History ..... 136

**Tomasz Figlus**  
The Past and Present of Historical Morphology of Rural and Urban Forms in Poland ..... 149

**Maryana Dolynska**  
Some Principles of Interdisciplinary Investigation  
for Recreating the Historical Topography of Urban Spaces ..... 169

*Atlas Fontium*

Atlas Fontium  
(Marek Słoń) ..... 185

**Tomasz Panecki, Tomasz Związek, Grzegorz Myrda**  
The Spatial Database Development for Research on Settlements  
and Afforestation in Nowy Tomyśl Plain in Early Modern Times ..... 186

**Marek Słoń, Urszula Zachara-Związek (eds.)**  
The Court Records of Wschowa (1495–1526). Digital Edition ..... 206

*Reviews and discussions*

Deutscher Historischer Städteatlas, Nr. 5: Dortmund,  
Hrsg. Peter Johaneke, Jürgen Lafrenz, Thomas Tippach, Münster 2018  
(Michał Słomski) ..... 221

\* \* \*

**Guidelines for Authors** ..... 229

# The Spatial Database Development for Research on Settlements and Afforestation in Nowy Tomyśl Plain in Early Modern Times\*



Tomasz Panecki, Tomasz Związek, Grzegorz Myrda

(<http://atlasfontium.pl/index.php?article=webhauand>)

## 1. Introduction

The digital revolution, which has drastically redefined the current geography's scientific apparatus and in some aspects drew it towards IT by the sole necessity of processing and analysing vast amounts of data, has started to influence other disciplines as well. The emergence of Geographical Information Systems (GIS) has not left the fields of archaeology, history, and social sciences unaffected. Where the spatial paradigm is a crucial component of scientific inquiry, GIS have become tools of acquiring, analyzing, and visualising data<sup>1</sup>. This turn towards “the space”, also called “spatial turn”, “spatial humanities”, or “historical GIS”, has become a widespread scientific trend, though it does not apply to, e.g. historical geography<sup>2</sup>. That is because even though GIS offered some new tools and consequently methodological repertoire, the field itself has involved the spatial component ever since its origins.

The authors of the article set themselves two main goals. The first one is to elaborate and publish in a form of a spatial database some selected materials for reconstruction of localities and afforestation in Nowy Tomyśl Plain (approx. 70 km west of Poznań) in the early modern era. Among the published resources, there are old topographical maps, archaeological data (Archaeological Survey of Poland – Pol. *Archeologiczne Zdjęcie Polski*) as well as processed and normalised data acquired from written sources (e.g. settlement privileges) and the literature. The second, but by no means less important, goal is to describe the architecture and functionalities of the application used in presenting the data.

The digitization of historical geography rendered its findings more verifiable. So far, the only critical apparatus at hand were the references, footnotes and maps attached to the text. They served a rather illustrative function, while the data at the core of their elaboration were only accessible for the author. Currently, the source data in geography (historical geography included) are increasingly frequently stored in the databases, or spreadsheets. As a result, the sources, their method of acquisition and elaboration can be verified by other researchers, provided the author willed and had a possibility to share them. Unfortunately, the current scientific journals, despite entering the digital era

\* The works on the database have been founded within the “Ontological foundations of the historical GIS” (Pol. *Ontologiczne podstawy budowy historycznych systemów informacji geograficznej*) contract no. 2bH15021683, financed by Narodowy Program Rozwoju Humanistyki under Bogumił Szady of Tadeusz Manteuffel Institute of History, Polish Academy of Sciences.

<sup>1</sup> I.N. Gregory, R.G. Healey, *Historical GIS: Structuring, Mapping and Analysing Geographies of the Past*, “Progress in Human Geography”, 31 (5), 2007, p. 638–653; J. Nita, U. Myga-Piątek, *Rola GIS w ocenie historycznych opracowań kartograficznych na przykładzie Wyżyny Częstochowskiej*, in: *Źródła kartograficzne w badaniach krajobrazu kulturowego*, red. J. Pliń, J. Nita, Sosnowiec 2012 (Komisja Krajobrazu Kulturowego Polskiego Towarzystwa Geograficznego, 16), p. 116–135; A. Affek, *Georeferencing of Historical Maps Using GIS, as Exemplified by the Austrian Military Surveys of Galicia*, “Geographia Polonica”, 86 (4), 2013, p. 337–390.

<sup>2</sup> *The Spatial Humanities: GIS and the Future of Humanities Scholarship*, ed. D. Bodenhamer, J. Corrigan, T. Harris, Indianapolis 2010.

by publishing online, still operate mostly on \*.pdf files, which are only a digitized paper version of the text and do not allow for publication in formats enabling full access and edition by the interested parties<sup>3</sup>. This also pertains to spatial data, which can be stored in text formats (WKT – Well Known Text, GeoJSON – Geographic JavaScript Object Notation, etc) despite their little efficiency and readability. The solution to the problem is the publication of the data in the form of a geoportal enabling its browsing, analyzing and downloading.

The database hereby presented is yet another recently announced publication on the settlements, administrative divisions and natural landscape transformations in Nowy Tomyśl Plain<sup>4</sup>. The foundation for the works stems from the experience gained during the elaboration of *Historical Atlas of Poland in the 2<sup>nd</sup> Half of the 16<sup>th</sup> Century*<sup>5</sup> (hereinafter: HAP). In this series the methodology of the reconstruction of settlements, administrative and ecclesiastical borders for the early modern age assumes the use of both written and cartographic sources. The written sources mostly date back to the 16<sup>th</sup> century, and serve as a basis for reconstruction of the administrative and political landscape, while the natural environment, including hydrography, afforestation due to lack of detailed maps from the period in question are delineated on the basis of the maps from the turn of the 18<sup>th</sup> and 19<sup>th</sup> century. Such methodology leads to time discrepancies in the data presented on the map, as the

settlement represents the 16<sup>th</sup> century while the land cover corresponds to a 300 year later date. The retrogressive method used during the works on the atlas usually produced satisfactory results and the physiographic contents matched the settlement component. However, in Nowy Tomyśl Plain area, it did not prove to be the case.

The Dutch settlements (or Hollander, Pol. *osadnictwo ołęderskie*) first introduced in the area at the turn of 17<sup>th</sup> and 18<sup>th</sup> century are not depicted on the HAP<sup>6</sup>; the forest, later grubbed by the inhabitants, and thus not presented on topographical maps from the turn of 18<sup>th</sup> and 19<sup>th</sup> century, is also missing (fig. 1). However, the analysed area had been explored by the inhabitants of the neighbouring villages, although the evidence suggests there were only temporary villages set up with the purpose of acquiring wood, forest fruits, bog iron, burning the charcoal, and soot and tar production. The existence of such villages can be traced on the basis of the onomastic remains, such as the names of the villages (e.g. Buda east of Chrośnica village) suggesting there was a temporary settlement<sup>7</sup>, or the location of the forge near Bouja village which is corroborated by the archaeological finds including the pottery used to produce soot<sup>8</sup> or lumps of glass, bricks, ceramics all indicating the presence of glassworks in the area (ASP: Archaeological Survey of Poland 54-21)<sup>9</sup>. The location, however,

<sup>3</sup> Although some publishers may add spatial data to the publication, e.g. \*.kml files (*Keyhole Markup Language*), these are only files, not an application whose functionalities allow to operate on the data.

<sup>4</sup> T. Związek, T. Panecki, *Osadnictwo ołęderskie w badaniach nad rekonstrukcją szesnastowiecznego zalesienia na przykładzie okolic Nowego Tomyśla*, "Studia Geohistorica", 5, 2017, p. 29.

<sup>5</sup> Recently there has been an English version of the previously printed volumes: *Historical Atlas of Poland in the 2<sup>nd</sup> Half of the 16<sup>th</sup> Century: Voivodeships of Cracow, Sandomierz, Lublin, Sieradz, Łęczyca, Rawa, Płock and Mazovia*, vol. 1–4, ed. M. Słoń, transl. A. Staszewska, M.A. Brożyna, Frankfurt am Main 2014, (Geschichte. S Politik: Posener Studien zur Geschichts- und Politikwissenschaft, 6).

<sup>6</sup> Our premise, presented in the previous article published in "Studia Geohistorica" (T. Związek, T. Panecki, *Osadnictwo*, p. 40) requires emendation. The Dutch settlement is known to exist in the area since the beginnings of the 17<sup>th</sup> century, as the sources confirming the location and operation of the glassworks suggest. For now, it is still unclear how far back should the first Dutch settlement be dated.

<sup>7</sup> J. Luciński, *Chrośnica*, in: *Słownik historyczno-geograficzny województwa poznańskiego w średniowieczu*, cz. 1, oprac. S. Chmielewski et al., Wrocław–Warszawa 1982, p. 223–224.

<sup>8</sup> A. Dymaczeński, *Ślady średniowiecznych smolarni w Wielkopolsce*, "Przegląd Archeologiczny", 9 (1), 1950, p. 123–124.

<sup>9</sup> Site no. 93–97, 102, 105, 108 i 125. The glassworks within the Dutch settlement was first mentioned in 1621. A. Wyrobisz, *Szkło w Polsce od XIV do XVIII w.*, Wrocław–Warszawa–Kraków 1968, p. 19. Cf. the Eva Černa's

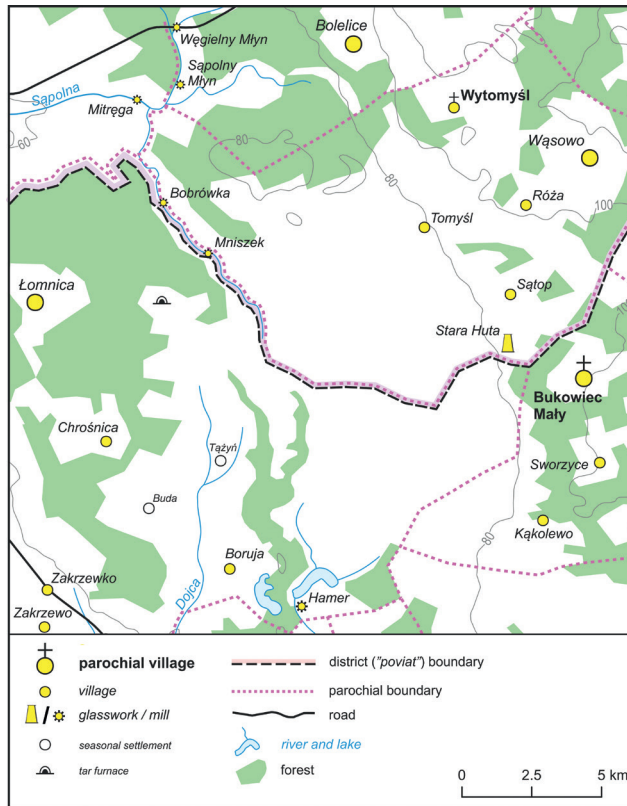


Fig. 1. The settlement void in the vicinity of Tomyśl in the 16<sup>th</sup> century.  
 Source: Own elaboration based on: "Województwo poznańskie w drugiej połowie XVI wieku", in: "Wielkopolska w drugiej połowie XVI w.", t. 1: "Mapy", red. K. Chtapowski, M. Stoń, Warszawa 2017 (Atlas Historyczny Polski. Mapy Szczegółowe XVI w., 4), map no. 1a

had not been a subject to permanent human activity and was not developed and transformed up until the introduction of Dutch settlements. Thus, understanding the location process and deforestation which is its consequence should enable the reconstruction of the forests covering the land before. Due to relative stability of the settlement network in Nowy Tomyśl Plain before the 18<sup>th</sup> century the reconstruction can even date as far back as to the previous centuries<sup>10</sup>.

Only at the turn of the 17<sup>th</sup> and 18<sup>th</sup> century, were the lands near Tomyśl subject to development of Dutch settlement, which had by no means left the natural landscape unscathed<sup>11</sup>. The colonists choosing mostly the wetlands and forested area grubbed the nearby forests transforming the relatively uncongenial and unwelcoming environment into a permanent habitat. Due to the character of the location, and the legal and ownership relationships the Dutch colonies were usually

observations on the glassworks' "migrations": E. Černa, *Středověké sklárny v severozápadních Čechách. Přínos archeologie k dějinám českého sklárství*, Most 2016, p. 193–209.

<sup>10</sup> T. Związek, T. Panecki, *Osadnictwo*, p. 39, map no. 2: *Wsie olęderskie wraz z informacją o terenie i czasie lokacji na obszarze Równiny Nowotomyskiej w XVII w.*

<sup>11</sup> W. Rusiński, *Osady tzw. "Olędrow" w dawnym woj. poznańskim*, Poznań–Kraków 1947; Z. Chodyta, *Pochodzenie, nazwiska, wyznanie i narodowość mieszkańców osad olęderskich założonych w latach 1700–ok. 1783 na obszarze dzisiejszego powiatu nowotomyskiego*, "Przegląd Nowotomyski", 18 (2), 2011, p. 3–22.

Zeilendorfs or primordial scattered villages, where each inhabitant was apportioned a specific amount of arable land<sup>12</sup>.

## 2. The architecture of the WebGIS platform

As stated above, the WebGIS platform is a tool enabling browsing and analysis of the spatial data. There are two components at its foundation: server (Geoserver dedicated to spatial data) and client (Heron Map Client and OpenLayers as a basis for the map application elaboration).

The data server is responsible for processing of data used in the project including both cartographic sources and objects' attributes, which together comprise an integrated database; on its basis the particular layers are generated which can be later viewed in the browser. The layers can be divided into three categories:

- Basemaps – scanned, mosaicked and georeferenced raster maps. The old maps in the case of our platform denote old topographical maps.

- Vector layers resulting from raster maps' digitization. Each feature on the map is connected with attribute data browsed and stored in the form of a table. It is possible to analyse them by using different spatial and topological operators (containing, intersection, etc.).

- External layers – viewed with use of WMS (Web Map Service), which is a default spatial data exchange standard supported by and implementing recommendations of OGC (Open Geospatial Consortium).

The Geoserver has been supplied with vector data in the form of a Shapefiles and raster data in GeoTIFF format, which results in a typical database data structure. The possibility of directly using the \*.shp and \*.tiff files is enabled as more complex database system is seen as unnecessary.

Using a database in this case, when there is little spatial and attribute information with fairly simple structure would result in the overall drop of the system efficiency. It also applies to the raster files where the efficiency was the key rationale for not using a database<sup>13</sup>.

Both the raster and vector files were configured at the level of Geoserver to enable access via WMS, a basic standard of data access for a client component in the OpenLayers browser. Additionally, each layer on the platform has been granted a style definition in the Geoserver, which also complies with the OGC SLD (Standard Layer Descriptor) standard. It account for the appropriate vector data presentation<sup>14</sup>. Due to that the entirety of the data is published in a standard way which allows for using any tools implementing the OGC standards.

In practice, using WMS in server-client communication or division into two separate parts each based on WMS service allowed for including in the system the ASP downloaded online from an external server <http://mapy.zabytek.gov.pl><sup>15</sup>. They can be found in the application under the *AZP index* layer.

The client GUI (Graphical User Interface) is dedicated for the web application designed particularly for the purpose of the project. The app employs components offered by Heron Map Client platform; the main component being the OpenLayers Library which is responsible for the map viewing. The remaining components provide features connected with the map itself, e.g. layer lists or presenting the information acquired from the map in the form of a table (for the vector layers). Irrespective of the viewing parameters of

<sup>12</sup> H. Szulc, *Morfogeneza osiedli wiejskich w Polsce*, Wrocław 1995 (Prace Geograficzne IGiPZ PAN, 163); T. Figlus, *Wsie olęderskie w Polsce Środkowej. Uwagi na temat zróżnicowania morfogenetycznego na tle rozwoju osadnictwa*, "Rocznik Łódzki", 62, 2014, p. 143–159.

<sup>13</sup> L. Litwin, G. Myrda, *Systemy Informacji Geograficznej. Zarządzanie danymi przestrzennymi w GIS, SIP, SIT, LIS*, Gliwice 2005.

<sup>14</sup> M. Lupp, *Styled Layer Descriptor Profile of the Web Map Service Implementation Specification* ([http://portal.opengeospatial.org/files/?artifact\\_id=22364](http://portal.opengeospatial.org/files/?artifact_id=22364), access: June 19, 2018).

<sup>15</sup> J. Beaujardiere, *OpenGIS® Web Map Server Implementation Specification* ([https://portal.opengeospatial.org/files/?artifact\\_id=14416](https://portal.opengeospatial.org/files/?artifact_id=14416), access: June 19, 2018).



the map specified in the Geoserver, there is also an array of parameters influencing the way the map is presented and its usage as a whole, which can be configured by the client. Using both sets of parameters and synchronising them provides grounds for a reasonable middle-of-the-road solution between the efficiency of the system and adequate map presentation. One of the key elements of the presentation, especially when it comes to the placement of the labels ascribed to the object, is the choice of the mode of communication with the server – sending a singular picture or tiles. The former results in the map being built of many smaller tiles concurrently downloaded from the server. Depending on the data structure paired with the viewing parameters of each layer, the presentation mode may need to be manually adjusted, separately for each layer, in order to arrive at the desirable result.

Consequently, the application enables presentation of the scanned and georeferenced raster maps (Basemaps), which constitute the basis for digitization, and the manuscript scans, from which the descriptive data was acquired. Some of the vector layers were ascribed a “SOURCE” attribute, which denotes the document they were based on. They also contain a column with a link to a manuscript scan. Generating such permalink connecting the scans with a particular map view and particular layers is an important feature of the application. It can, in fact, eliminate the need to illustrate the text of a publication as the links can directly connect to a digital map, which the user can zoom in or out, and browse the attributes thereof. Moreover, for the more advanced users, it is possible to download the entire geodatabase (\*.mdb).

### 3. Thematic layers

In GIS, the term *thematic layer* denotes similar or uniform sets of data in terms of its function, character, or topic. In case

of the materials used in the reconstruction of the afforestation, we decided to divide the data on technical grounds into four categories<sup>16</sup>:

- Basemaps,
- Settlements and Administrative Divisions,
- Natural Landscape,
- Forest Reconstruction Data.

Thanks to such a division it is possible to view the old maps as basemaps and geodetic control network for the remaining data, view the reconstructed administrative divisions (from the two periods: the 16<sup>th</sup> and the 18<sup>th</sup> century) as well as the data directly connected with the issue of afforestation reconstruction (table 1).

Data elaborated for the purpose of the application can be divided according to another criterion – the degree of data processing and elaboration. That is because the layers acquired from the external projects, like HAP or ASP and sources elaborated for the purpose of the project in question, like georeferenced maps and elaborated external sources in the form of a database are qualitatively different. This is reflected in the column *Layer type* in table 1. For instance, within “Forest reconstruction data” group of layers we can find mostly the visualizations of the data from a monograph by Władysław Rusiński, and the effects of old maps digitization, but also the results of spatial analyses (buffers, forested/deforested areas, etc.).

Generally, the data has been processed using GIS, which served as a platform of spatial and attribute information means of integration and acquisition. The first

<sup>16</sup> The database was presented during the 11<sup>th</sup> “Digital Approaches to Cartographic Heritage” on April, 20–22, 2016 in Riga. That is why in order to disseminate the materials hereby presented we decided to maintain the English as the language of the application. Our preliminary findings have been briefly discussed in a paper published after the conference. Cf. T. Panecki, T. Związek, *The so-called Dutch Colonization in 18<sup>th</sup> c. Greater Poland: Research Project on AtlasFontium.pl WebGIS Platform*, in: *Digital Approaches to Cartographic Heritage*, ed. E. Livieratos, Thessaloniki 2016, p. 344–356.



Table 1. The assortment of the thematic maps under elaboration

Group of layers	Name of the layer	Layer type	Layer/table name
Basemaps	Urmesstischblätter	georeferenced old map	not applicable
Basemaps	Gilly-Cron	ditto	n/a
Basemaps	Messtischblätter	ditto	n/a
Basemaps	Topographic, 21 <sup>st</sup> c.	WMS	n/a
Basemaps	Digital Elevation Model	WMS	n/a
Settlements and administrative divisions	Settlements in the 16 <sup>th</sup> c.	Data acquired form HAP	HAP_Settle_16c
Settlements and administrative divisions	Administrative units in the 16 <sup>th</sup> c.	ditto	HAP_adm_16c
Settlements and administrative divisions	Dutch-type settlements in the early 19 <sup>th</sup> c.	Reconstruction based on the written and cartographic sources	Holl_adm_19c
Natural landscape	Rivers [UMTB]	Digitization and generalisation of the old map	UMTB_Hydro_Line
Natural landscape	Lakes [UMTB]	ditto	UMTB_Hydro_Polygon
Natural landscape	Forests [Gilly-Cron]	ditto	GK_forests
Natural landscape	Forests [UMTB]	ditto	UMTB_forests
Natural landscape	Forests [HAP]	Data acquired form HAP	HAP_forests
Forest reconstruction data	Dutch-type farms in the early 19 <sup>th</sup> c.	Digitization and generalisation of the old map	Holl_farms_19c
Forest reconstruction data	Date and type of location	Data visualization based on the literature	DateAndLocation
Forest reconstruction data	Farms quantity in the late 18 <sup>th</sup> c.	ditto	FarmsQuantity_late18c
Forest reconstruction data	Village population in the late 18 <sup>th</sup> c.	ditto	Population_late18c
Forest reconstruction data	Farms quantity in the early 19 <sup>th</sup> c.	Digitization and generalisation of the old map	FarmsQuantity_early19c
Forest reconstruction data	Onomastic information	Reconstruction based on the written and cartographic sources	Onomastics
Forest reconstruction data	ASP survey (Archaeological Survey of Poland)	ASP data	ASP
Forest reconstruction data	ASP index [WMS]	Data acquired from ASP, WMS	n/a
Forest reconstruction data	Forest area per village in early 19 <sup>th</sup> c.	Spatial analysis	ForestArea_early19c
Forest reconstruction data	Deforested/Clear area per village in early 19 <sup>th</sup> c.	ditto	NoForestArea
Forest reconstruction data	Potential forest area per village	ditto	Pot_ForestPerFarmArea
Forest reconstruction data	10 hectares' buffer	ditto	Buffer_10ha
Forest reconstruction data	15 hectares' buffer	ditto	Buffer_15ha
Forest reconstruction data	20 hectares' buffer	ditto	Buffer_20ha
Forest reconstruction data	25 hectares' buffer	ditto	Buffer_25ha
Forest reconstruction data	Thiessen Polygon	ditto	Thiessen_polygon
Forest reconstruction data	Vegetation types	Reconstruction based on written and cartographic sources	Vegetation_type
Forest reconstruction data	Soil types	Vectorization of selected information from the soil-agricultural map 1:100,000	Soils
Forest reconstruction data	Potential Natural Vegetation	Vectorization of selected information from Potential Natural Vegetation Maps of Poland	Potential_natural_vegetation

step was to elaborate the spatial database with information on the natural and administrative landscape of the area under scrutiny, which would date back to the turn of the 18<sup>th</sup> and 19<sup>th</sup> century. In order to do that, old maps (e.g. Gilly-Cron, *Urmesstischblätter*, and *Messtischblätter*), old Dutch privileges, as well as literature were used, most of which come from Rusiński's monograph<sup>17</sup>.

### 3.1. Basemaps

The role of the base maps in WebGIS is twofold: they serve the purpose of spatial reference for the remaining data and work as a source of information. The data acquired from them concerned the topography of Nowy Tomyśl Plain in the 18<sup>th</sup> and the 19<sup>th</sup> century as well as natural and administrative landscape.

The oldest map among those used is the manuscript of *Karte von Südpreußen* by David Gilly and Cron from 1793 (Gilly-Cron). It depicted the area occupied by Prussia after the second partition of Poland. The map, despite its large scale (1:50,000) is not precise due to its method of elaboration (*a l'oeil*) – instead of triangulation only compass measurements and estimation were used. The maps greatest advantage is the fact that it reflects the topography from the end of the 18<sup>th</sup> century before the landscape and administrative transformations of the 19<sup>th</sup> century<sup>18</sup>. Three map sheets (*Zbąszyń*, *Kamienna*, and *Buk*) were used in the analysis.

Another map used in the project is *Urmesstischblätter* (UMTB) which is a manuscript of a topographical survey from 1820s and 30s conducted by Prussians in scale 1:25,000. The elaboration of the

map was preceded by triangulation, which resulted in its relatively accurate geodetic network, and high – for that time – overall precision. The surveyors conducted the field measurements mapping almost all the elements of the landscape resorting to only minor generalization. The map was not supposed to be published and remained solely in the manuscript<sup>19</sup>. The researchers stress a high precision and detail of the map, though they also remark inconsistencies in the symbology between the sheets<sup>20</sup>. The six sheets used in the analysis are: *Trzciel* (sheet no. 1991), *Nowy Tomyśl* (no. 1992), *Wąsowo* (no. 1993), *Zbąszyń* (no. 2058), *Boruja* (no. 2059), *Kąkolewo* (no. 2060).

Finally, the last map under scrutiny was a German plane table survey from the end of 19<sup>th</sup> century – *Messtischblätter* (MTB). It was a successor of *Urmesstischblätter* described above and therefore was also printed to the scale of 1:25,000. It was, however, preceded by a completely new triangulation and had, in contrast to its predecessor – a fixed set of cartographic symbols<sup>21</sup>. The map sheet's symbols reflected those of *Urmesstischblätter* and have been acquired from the "Archiwum Map Wojskowego Instytutu Geograficznego 1919–1939" website<sup>22</sup>.

The use of analogue raster maps as basemaps or a source of data in GIS was only possible after their prior georeferencing (i.e. placing the maps in the chosen projection). The process involves indicating pairs of control points on a map and on the reference material (another map or given set of coordinates) which results in linking the two data sets. When it comes to old maps, this process has gained extensive attention in the literature, though

<sup>17</sup> W. Rusiński, *Osady*, p. 123–144.

<sup>18</sup> K. Buczek, *Prace kartografów pruskich w Polsce za czasów Stanisława Augusta na tle współczesnej kartografii polskiej*, Kraków 1935 (Prace Komisji Atlasu Historycznego Polski, 3); W. Scharfe, *Abriss der Kartographie Brandenburgs 1771–1821*, Berlin–New York 1972; B. Medyńska-Gulij, D. Lorek, *Pruskie mapy topograficzne dla Wielkopolski do 1803 roku*, "Badania Fizjograficzne nad Polską Zachodnią. Seria A: Geografia Fizyczna", 59, 2008, p. 29–42.

<sup>19</sup> W. Scharfe, *Abriss*, passim; A. Konias, *Kartografia topograficzna państwa i zaboru pruskiego od II połowy XVIII wieku do połowy XX wieku*, Słupsk 2010.

<sup>20</sup> D. Lorek, *Potencjal informacyjny map topograficznych Urmesstischblätter z lat 1822–33 z terenu Wielkopolski*, Poznań 2011.

<sup>21</sup> A. Konias, *Kartografia*, passim.

<sup>22</sup> <http://polski.mapywig.org/news.php> (access: June 19, 2018).

no uniform approach has been elaborated as of yet<sup>23</sup>. In GIS software, there are a number of methods enabling transformation of a georeferenced map. The two most common are: linear, which assumes only displacement, change of scale, and rotation<sup>24</sup> and polynomial, which interferes with the internal alignment of pixels deforming it locally, while at the same time resulting in a greater detail of adjustment if a bigger number of control points are used<sup>25</sup>. Currently, it is widely assumed that georeferencing the old maps should be based on the polynomial transformations, while for the maps with geodetic control network it is possible to use the linear ones<sup>26</sup>.

The georeferencing of the maps was conducted in a following manner: the sheets *Karte von Südpreußen* first mosaicked (connected) in CorelDraw in order to eradicate the unnecessary content beyond the map frame. Such elaborated map was then georeferenced in ArcGIS 10.2 using linear transformation with 23 adjustment points. The Root Mean Square error (RMS), which depicts the degree of accuracy of the calibration was at 246 meters<sup>27</sup>. However, UMTB and MTB's georeferencing was somewhat different. Due to the same angular size of the two maps a  $6' \varphi$  on  $10' \lambda$  network was generated for the sheet in *Deutsches*

*Hauptdreiecksnetz* datum, which served as a basis for the calibration and enabled cropping the map frames and mosaicking<sup>28</sup>. RMS for UMTB was 143 meters (50 control points), while for MTB 13 meters (also 50 points)<sup>29</sup>.

The role of current reference data was played by two layers from Geoportal ([www.geoportal.gov.pl](http://www.geoportal.gov.pl)): a collection of topographic maps in scales 1:10,000, 1:25,000, and 1:50,000, which can be viewed in different scales depending on the zoom chosen by the user, and the Digital Terrain Model (DTM) illustrated with shading. Both components comply with WMS standard.

### 3.2. Settlement and administrative division

#### 16<sup>th</sup> century settlements

The layer contains data on the settlement in the 16<sup>th</sup> century, which stems from the data elaborated for the HAP<sup>30</sup>. The area of Nowy Tomysł Plain was surrounded by villages owned by the nobility mostly belonging to Zbąski and Lwowski families<sup>31</sup>. In the area, there were also mills, a forge, and a saw also governed by the nobility.

#### The 16<sup>th</sup> century administrative division

In the 16<sup>th</sup> century, the area under scrutiny was divided into two districts (Poznań in the north and Kościan in the south) which comprised Poznań voivodeship<sup>32</sup>.

<sup>23</sup> J. Wolski, *Błędy i niepewność w procesie tworzenia map numerycznych*, in: *Źródła kartograficzne*, p. 15–32; K. Lange, *Kalibracja dawnych map zasięgu lodów morskich w Arktyce z zastosowaniem systemów informacji geograficznej*, "Polski Przegląd Kartograficzny", 45 (4), 2013, p. 344–351; T. Panecki, *Problemy kalibracji mapy szczegółowej Polski w skali 1:25 000 Wojskowego Instytutu Geograficznego w Warszawie*, "Polski Przegląd Kartograficzny", 46 (2), 2014, p. 162–172.

<sup>24</sup> For instance, the Helmert's transformation in QGIS.

<sup>25</sup> For example, affine transformation (first order polynomial), second and third order polynomial in ArcGIS, as well as Spline transformation (ArcGIS) and TPS – Thin Plane Spline (QGIS), which locally match pairs of control points.

<sup>26</sup> A. Affek, *Kalibracja map historycznych z zastosowaniem GIS*, in: *Źródła kartograficzne*, p. 48–62; M. Jaskulski, G. Łukasiewicz, M. Nalej, *Porównanie metod transformacji map historycznych*, "Roczniki Geomatyki", 61 (4), 2013, p. 42–57.

<sup>27</sup> The RMS is an average of the distance between the points on a calibrated map and a reference material. J. Urbański, *GIS w badaniach przyrodniczych*, Gdańsk 2008.

<sup>28</sup> T. Panecki, *Problemy*, p. 162–172.

<sup>29</sup> Control points were stable and immutable landmarks, e.g. churches and intersections of important roads.

<sup>30</sup> The data inserted into the geodatabase contain information on the 16<sup>th</sup> century and current name of the village, its character, ownership, and a type of location. An ID enabling linking it to atlasfontium.pl was also included.

<sup>31</sup> *Rejestry poborowe województwa poznańskiego w XVI w.*, red. M. Słoń, oprac. A. Borek et al., "Atlas Źródeł i Materiałów do Dziejów Dawnej Polski", 3, 2015 [online], ISSN: 2353–9216 (<http://www.atlasfontium.pl/index.php?article=poznańskie>, access: September 7, 2017).

<sup>32</sup> A. Gąsiorowski, *Powiat w Wielkopolsce XIV–XVI w. Z zagadnień zarządu terytorialnego i podziałów Polski późnośredniowiecznej*, Poznań 1965; *Wielkopolska w drugiej połowie XVI w.*, t. 1: *Mapy*, red. K. Chłapowski, M. Słoń, Warszawa 2017 (Atlas Historyczny Polski. Mapy Szczegółowe XVI w., 4), maps 1a, 1b.

The 18<sup>th</sup> century Dutch settlement

The 18<sup>th</sup> century settlements in Nowy Tomysł Plain was morphologically different from the prior structures. The scattered character of the villages resulted in difficulties in delineating the borders between them, based on the written and cartographic sources and had a significant error margin<sup>33</sup>. The proposed divisions between the villages were the effect of retrogressive reconstruction works drawing mostly on cartographic material.

At the first stage of the reconstruction works, we decided to acquire the spatial data from *Urmesstischblätter* on particular farms, which we marked with point symbols (*Forest reconstruction data* → *Dutch-type farms in early 19<sup>th</sup> c.*). However, the problem arose, when the villages were not of a scattered character, like Borujskie Stare Olędry with a church square in the middle (Kirchplatz on *Urmesstischblätter*) comprising the build-up area (gardens) and an array of buildings (fig. 2). In such cases we decided to assume 3 buildings as one point, as three or four buildings usually constitute one farm<sup>34</sup>.

The next step was a reconstruction of the Dutch villages on the foundation of the prior vectorized farms, delineating the administrative borders and placement of the villages' names on *Urmesstischblätter*. Basing on that, it was possible to determine the affiliation to a particular village. The process also involved the much later *Messtischblätter* where almost all groups of farms were supplemented with the annotation "zu [name of the village]" or (sometimes) linear borders, which enabled assignment of farm to particular Dutch villages (fig. 3). Such elaborated data served as a basis for border delimitation; a farm was a centre around which a Thiessen

polygon was generated, then a name of the village was added as an attribute (*Forest reconstruction data* → *Thiessen polygons*). Subsequently, the polygons were merged (function *dissolve* in ArcGIS) according to the name attribute and after the cartographic editing (e.g. adjustment to the natural boundaries and barriers in accordance to the newer maps) the particular villages' borders were drawn. This approach is relatively new in historical geography; generating boundaries based on Thiessen polygons is a very approximate model, however, as shown by Bogumił Szady's studies quite corresponds to reality<sup>35</sup>. In our case, Thiessen polygons served as one of the stages of border reconstruction, not the final effect. Final geometry of borders was adapted to natural obstacles, as well as later boundaries later observed in the area (according to *Messtischblätter*). The layer except the names of the villages also contained the scanned Dutch settlement privileges acquired from National Archives in Poznań (this pertains to villages: Chojnickie Olędry, Cisogórskie Olędry, Paproć Olędry, Róża Olędry, Sękowo Olędry and Zielonka Olędry)<sup>36</sup>. Some of the sources have also been edited and printed<sup>37</sup>.

### 3.3. Natural landscape

#### Hydrography

The thematic layers on hydrography were elaborated on the basis of UMTB sheets. From the perspective of the afforestation reconstruction, the issue of drainage system is important with respect to the to the

<sup>33</sup> A. Oliskiewicz-Krzywicka, *Kształtowanie się granic wsi w wyniku kolonizacji olędzkiej na terenie Wielkopolski*, "Przegląd Geodezyjny", 75, 2003, p. 15–20; T. Figlus, *Wsie*, p. 143–159.

<sup>34</sup> A. Pelczyk, *Poolędzkie budownictwo mieszkalne na obszarze równiny nowotomyskiej*, "Studia Lednickie", 4, 1996, p. 357–377.

<sup>35</sup> Cf. B. Szady, *Granice powiatu łukowskiego w II połowie XVIII wieku – model liniowy i sieciowy*, in: *Narrata de fontibus hausta. Studia nad problematyką kościelną, polityczną i archiwalistyczną ofiarowane Janowi Skarbowski w siedemdziesiąt rocznicę urodzin*, red. A. Barańska, W. Matwiejczyk, Lublin 2010, p. 831–854.

<sup>36</sup> They were found in Poznań National Archive in the court books no. 1123, 1130, 1204, 1205, 1206, 1207, 1208. Except that, one document was found in Kościan court book no. 214, while two of them in Land Books no. 173 and 209.

<sup>37</sup> T. Związek, T. Panecki, *Osadnictwo*, p. 49–59.





Fig. 2. Kirchplatz along with digitized Dutch farms.

Cf. [http://atlas.iopan.edu.pl/gis/hauland/index.html?map\\_x=304484&map\\_y=493011&map\\_zoom=3&map\\_visibility\\_Urmesstischblätter=true](http://atlas.iopan.edu.pl/gis/hauland/index.html?map_x=304484&map_y=493011&map_zoom=3&map_visibility_Urmesstischblätter=true) (access: June 2, 2018)



Fig. 3. The additional names of the settlements by the farms which ascribe it to particular villages.

Source: [http://atlas.iopan.edu.pl/gis/hauland/index.html?map\\_x=307038&map\\_y=492828&map\\_zoom=2&map\\_visibility\\_Urmesstischblätter=true](http://atlas.iopan.edu.pl/gis/hauland/index.html?map_x=307038&map_y=492828&map_zoom=2&map_visibility_Urmesstischblätter=true) (access: May 17, 2018)

rivers, streams, and canals. The layer Rivers [UMTB] contains watercourses with division into rivers (Ger. *Flusse*), streams (*Bache*), wet canals (“*Nasse Graben*”) and dry ones (“*Trockne Graben*”) <sup>38</sup>. A name of the watercourse was added, where possible, as well as an id from the *Digital Dictionary of Hydronyms of Poland* (Pol.: *Elektroniczny Sownik Hydronimów Polski*; ESHP) <sup>39</sup>. The spatial data was acquired without, or with limited, generalization in a degree corresponding to the source data.

#### Afforestation

This collection of data consists of three layers: the forested area elaborated for HAP (layer: *Forests [HAP]*), the forested area acquired from Gilly-Cron (layer: *Forests [Gilly-Cron]*) and from UMTB (layer: *Forests [UMTB]*). The afforestation, along with hydrography acquired from HAP, according the principles underlying series’ publication, is supposed to play the role of a cartographic basis and basemap for settlement and administrative boundaries in the 16<sup>th</sup> century. As it has been stated above, the layer does not serve such a purpose for the area in question due to the later appearance of later, 18<sup>th</sup> century Dutch settlement. Thus, including the state of settlement development from HAP in our set of materials stems from the need to visualize the discrepancies between the information on physiography (18<sup>th</sup> century) and settlement (16<sup>th</sup> century).

The forests acquired from Gilly-Cron and UMTB directly serve the purpose of reconstruction and can be somewhat viewed as the inventory of the state of Nowy Tomyśl Plain afforestation at the end of 18<sup>th</sup> (ca. 1793) and the first half of 19<sup>th</sup> century (ca. 1830). The juxtaposition of the data though in different scales and based on different editing assumptions enables analysis of the afforestation changes’

dynamics since the last phases of settlement until the end of the colonization in the area. The method of acquisition of afforestation data from the said maps assumes uniform treatment of the bushes and forests and aggregating them to forest cover in the end-result database. UMTB (in scale 1:25,000) was a little quantitatively generalized to render it comparable to Gilly-Cron (1:50,000). The generalization affected mostly the graphics, by merging the neighbouring polygons or by line simplification.

#### 3.4. The data on afforestation reconstruction

Within this set of layers there is data directly connected with the process of reconstruction of the forests in Nowy Tomyśl Plain which enables to deline their borders, area and type. The data can be divided into a number of types: the preliminary data and auxiliary data, such as: date and location of the village, number of households, population constitute a somewhat general overview of the situation and depiction of the settlement dynamics and geographical variety of the villages’ demography <sup>40</sup>. Thanks to ASP data it was possible to partially reconstruct on the basis of the ceramics found in the transect the forest borders prior to the Dutch colonization. The data with a potential forest area per one farm, buffers around them, and Thiessen polygons are all used to calculate the forest cover basing on the 19<sup>th</sup> century settlement data. On the other hand, the onomastic information concerning the Dutch villages can help estimate the potential type of the forest as they contain the toponyms derived from forest names <sup>41</sup>. They are supplemented with data on vegetation acquired from the maps both old and new. The materials include also *soil* and *potential natural vegetation* layers developed on the basis of soil

<sup>38</sup> *Src\_type* column.

<sup>39</sup> *ID\_eshp* column; *Elektroniczny słownik hydronimów Polski* (<http://eshp.jpj-pan.krakow.pl/oslowniku/>, access: June 12, 2018).

<sup>40</sup> On the basis of W. Rusiński’s monography (ditto, *Osady*).

<sup>41</sup> T. Związek, T. Panecki, *Osadnictwo*, p. 42–45.

and agricultural maps at 1:100,000<sup>42</sup> and the map of Potential Natural Vegetation<sup>43</sup>.

#### The Dutch farms at the beginnings of the 19<sup>th</sup> century

The layer contains the Dutch settlement farms acquired from UMTB in point topology (one point representing one farm). Our main assumption was placing the point in the centre of gravity of each farm, which usually comprised 3–4 buildings. Due to the settlements' morphogenesis (scattered rural colonies) the majority of the farms adhered to these assumptions with exception to the aforementioned Boruja Kościelna (Kirchplatz on UMTB).

#### Date and place of village location

The Dutch settlement was first introduced to Nowy Tomyśl Plain by Ludwik Szołdrski and his successors in the 17<sup>th</sup> and 18<sup>th</sup> century<sup>44</sup>. From the day one, the settlers logged and dried the area, what is corroborated by, among those, the privileges granted to the colonists<sup>45</sup>. The settlers' activities in Nowy Tomyśl Plain follow the common practice in the entire Poznań voivodship in the 18<sup>th</sup> century.

Two of the villages (Sękowo Olędry and Glinki Olędry) were established in 1700 and 1701 and were located in the area during prior (though failed) attempts to settle. Near them, there were villages Paproć Olędry (1701) and Zielonka (1704), whose inhabitants were obliged to grub up the forest and the neighbouring copses and thickets in the assumed location; the colonies on the verge of the area under scrutiny – in the east, south and west – are late locations, as they were established

in the later 18<sup>th</sup> century. The arrangement and chronology of the location (chart 1 and 2) suggest that originally the areas south-west of Nowy Tomyśl were supposed to be developed and at that time the subject of interest were the peripheral parts of the forest, which were easier to clear.

The data in the application contain the information on the name of the settlement (according to Władysław Rusiński) date and place of location<sup>46</sup>.

#### The number of households and population at the end of the 18<sup>th</sup> century

The data corpus on the Dutch settlement bases on the entries of Władysław Rusiński attached to his monograph on the said type of settlement in Greater Poland. The researcher in his work presented the key information on location and demographic potential for each identified settlement, such as the year of foundation, type of the terrain, number of households, and people in some of the villages (number of households: layer *Forest reconstruction data* → *Farms quantity in late 18<sup>th</sup> c.*). The statistical data for the period in question despite being differently preserved still pose high source validity. The number of households prior estimated was multiplied by the demographic indicator given by Rusiński, which according to his calculations equalled 6,05 people per household in Kościan district. The calculations allowed for delineating the population density zones with the highest indicator per one household in villages Grubskie Olędry and Czeskie Olędry (population: layer *Forest reconstruction data* → *Village population in late 18<sup>th</sup> c.*). Unfortunately, the majority of the villages lack data allowing to calculate the said indicator, however, some observations on the population density trends can lead to some conclusions. Firstly, the villages with high

<sup>42</sup> T. Witek, *Mapy glebowo-rolnicze oraz kierunki ich wykorzystania*, Puławy 1973.

<sup>43</sup> W. Matuszkiewicz et al., *Potencjalna roślinność naturalna Polski. Mapa przeglądowa 1:300 000*. sheets 1–12, Warszawa 1995.

<sup>44</sup> M. Zwierzykowski, *Szoldrski Ludwik Bartłomiej h. Łódzia (1675–1749)*, in: *Polski słownik biograficzny*, t. 48, red. A. Romanowski et al., Warszawa–Kraków 2013, p. 516–520; T. Związek, T. Panecki, *Osadnictwo*, p. 46–47 along with annex.

<sup>45</sup> Cf. *ibidem*, p. 49–59.

<sup>46</sup> Columns: *Name, Date, Location*.



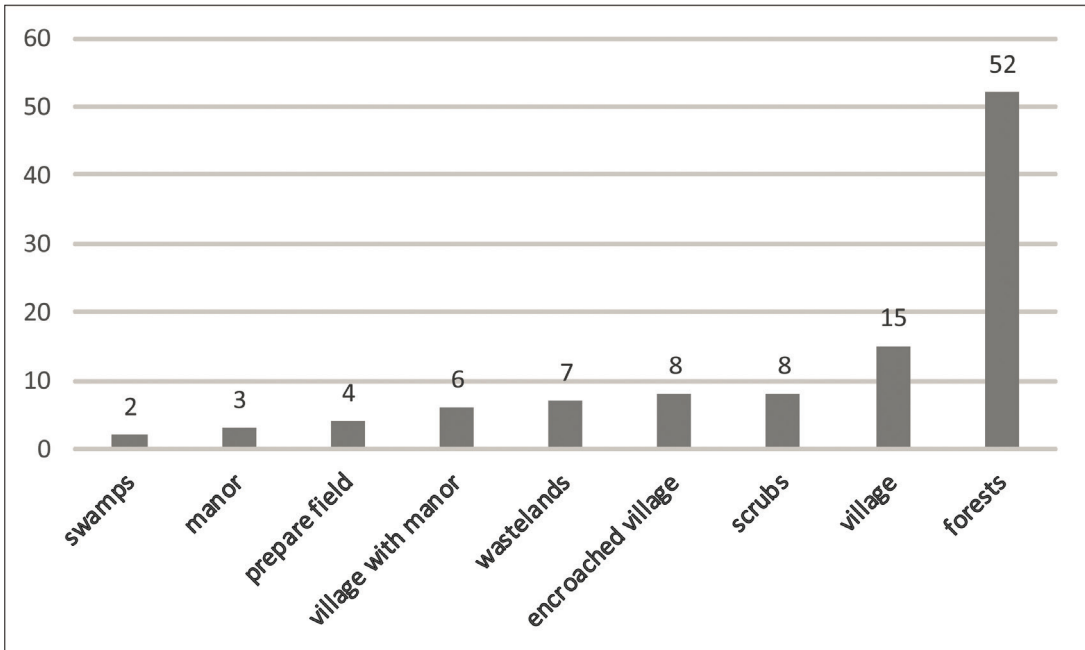


Chart 1. The terrain types for the location of Dutch settlements in Poznań voivodship in years 1597–1787.  
 Source: Own elaboration based on the Rusiński's monograph

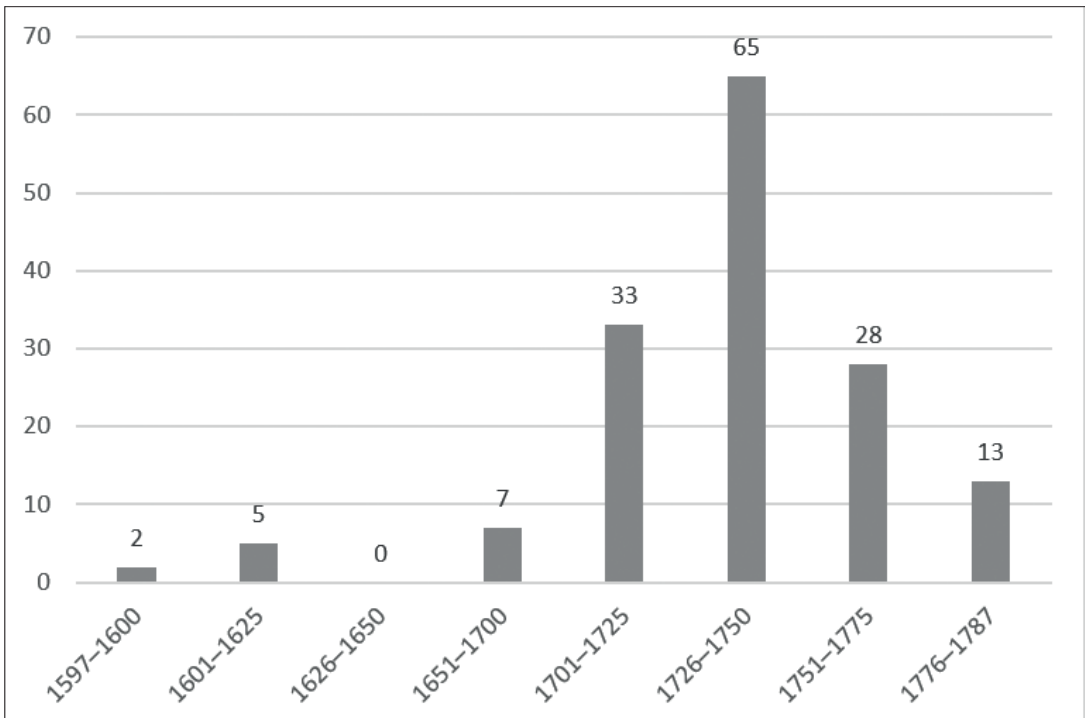


Chart 2. The chronology of the Dutch settlement location in Poznań voivodship in the 18<sup>th</sup> century.  
 Source: Own elaboration based on the Rusiński's monograph

population potential can be the relics of the locations prior occupied rather than the others in the area; consequently, they can serve as reference points in estimating the scale of difficulty in preparation and exploitation of particular areas. Having made the above assumptions, we can expect the more densely populated areas to have been inhabited earlier as their exploitation did not pose significant problems for the new coming colonists as well as the coming-of-age children on the colonists already settled.

The number of the farms in the 19<sup>th</sup> century

The layer depicts the number of Dutch farms acquired from *Urmesstischblätter*. It is important from the point of view of the dynamics of the settlement development juxtaposed with the number of households given by Rusiński.

The onomastic information on the villages

The names of the Dutch villages in Nowy Tomyśl Plain can be divided into three basic categories<sup>47</sup>.

The first one comprises the natural and (partially) terrain-bound names: *Cicha* (*Cisia*) *Góra*, *Sucha Dębina*, *Paproć Olędry*, *Sękowo*, *Zielonka*, *Kozielaski Olędry*, *Starodąbrowskie Olędry*, *Białe Olędry*, *Czarne Olędry*, *Łęczne Olędry*, *Kopanki Olędry*.

The second one comprises the names denoting the previous (the 15<sup>th</sup> and 16<sup>th</sup> century) settlements: *Bolewickie Olędry*, *Borujskie Stare* and *Nowe Olędry*, *Starojastrzębskie Olędry*, *Nowojastrzębskie Olędry*, *Różyńskie Olędry*, *Sapólna Olędry*.

The third one consists of the names most probably derived from the surnames of the locators and other ethnic groups: *Albertowskie Olędry*, *Amtskasnerowskie Olę-*

*dry*, *Czeskie Olędry*, *Niemiecko-Czeskie Olędry*, *Stefanowskie Olędry*. These names, due to their etymology, are of no value for the afforestation reconstruction of the area.

Archaeological Survey of Poland (ASP)

The data gathered in the national programme “Archaeological Survey of Poland” (Pol. *Archeologiczne Zdjęcie Polski*) play a supplementary role. They have been gathered from the end of the 70s and 80s of the 20<sup>th</sup> century and stored in the form of ASP record cards containing the description of the findings, their spatial context (maps in scales 1:10,000, “1965” datum) with their number and approximate chronology. The most common information in this source pertains to the number of found ceramic pieces, findings connected with steelwork, and others. For the described project it was possible to use the data from nine ASP regions. They pertained to the settlement from the early Middle Ages until the modern era understood as the turn of the 18<sup>th</sup> and 19<sup>th</sup> century. In the query, we omitted the information on the settlements from the Migration Period or pre-historic times; what was of interest for us were solely the findings connected with the human activity in the Middle Ages and the modern age. However, the materials despite their great potential are not without flaws.

We have discovered, that the field survey conducted were preceded (or not) with quite poor archive query sometimes only limited to a brief overview of the materials pertaining to the particular sheet in the local archaeological archive and/or Provincial Heritage Monuments Protection Office. The archaeologists gathering and describing the materials found in the course of the survey were often disinterested in recognising their origin or lacked knowledge to do so when they lay

<sup>47</sup> M. Rutkiewicz, *Sposoby tworzenia wielkopolskich nazw osad olęderskich*, in: *Toponimia i oronimia*, red. A. Cieślakowa, B. Czopek-Kopciuch, Kraków 2001, p. 155–168; Z. Zierhofferowa, *Nazwy osad olęderskich w Wielkopolsce. Powstanie i zmiany* ([http://holland.org.pl/art.php?kat=art&dzial=konf\\_2001&id=6](http://holland.org.pl/art.php?kat=art&dzial=konf_2001&id=6), access: April 18, 2016); T. Związek, T. Panecki, *Osady olęderskie*, p. 42–44.

out of the scope of their specialty<sup>48</sup>. Such conduct often resulted in the overuse the term *settlement* (Pol. *osada*)<sup>49</sup>, which occurred 140 times, and using interchangeably the terms *settlement traits* (Pol. *ślady osadniczne*) – 233 occurrences, and *settlement points* (Pol. *punkty osadnicze*) – 151 occurrences. Not all those shortcomings stem from the methodology of elaboration of ASP documentation itself, thus being the common mistakes in the field survey research. Some of the areas under scrutiny of our research (53-18, 54-18, 54-19) have not been surveyed as of yet and that is why their documentation was missing in the archive query.

Drawing on the above, the ASP material presented in the project mostly comes from the areas 53-19, 53-20, 53-21, 53-22, 54-21, 55-19, 55-21, and 56-19. In the course of the archive works, 429 archaeological sites were entered, some differently evaluated: 23 sites (mostly early medieval) described as ones with high scientific value potential; 129 with medium scientific potential, while 273 with little value, three were not evaluated whatsoever. Such indicators refer to potential of possible archaeological sites, if there established. Thus, it is worth having in mind, that the ceramics usually surround the settlements dating way further back than to the 18<sup>th</sup> century – in our case those will be the villages from the 15<sup>th</sup> and 16<sup>th</sup> century. We decided that only the sites where more than 5 pieces of ceramics were found will be presented in the project.

<sup>48</sup> An example of such a procedure is area 56-20, where it is known from written sources that there was a 16<sup>th</sup> century forging compound. Comparing the known areas of medieval and early modern ironworks, one would expect in this area to pour out potential archaeological materials in the form of relicts of millstones, numerous ceramic fractions and even pieces of slag (see even the area of ASP 40-19). Unfortunately, this area belonged to one of the most poor in terms of elaboration. The chronology of ceramic materials found there ended practically during the La Tène period, and there was also no master map that would help in the location of individual stands. We had similar reservations regarding the implementation of area 55-18.

<sup>49</sup> The term was used in places where at least four ceramics pieces were found.

In the application and the database there is information on the ASP area, type of the archaeological site, chronology, number of ceramics fragments and their density (table 2).

#### Archaeological Survey of Poland sections' index

The index of the ASP areas is shared via WMS by National Heritage Board of Poland (Pol. *Narodowy Instytut Dziedzictwa*) 50.

#### The forest in villages at the beginning of the 19<sup>th</sup> century

For each village from *Dutch settlements in the 18<sup>th</sup> c.* layer, the area covered by the forest (hectares) at the beginnings of the 19<sup>th</sup> century was calculated (source of the data – forests from UMTB). The data was then normalised with use of the size of the village, which resulted in the percentage afforestation indicator (column *norm*), which maximum value can be observed in Bolewickie Ołędry, and minimum in Rojewskie Ołędry (no forest whatsoever).

#### The area without forest cover at the beginning of the 19<sup>th</sup> century

In contrast to the previous layer the area without forest was calculated within the boundaries of the villages, normalised using the acreage of the village, and then visualised with a choropleth map.

#### The potential forest area per one farm

The layer contains the results of the analysis conducted on the layers containing the area not covered with forest within the village and the number of farms. The analysis involved dividing the area without forest by the number of the farms thus arriving at the potential forest area per one farm. The indicator's idea stems from the assumption that the area of the village before

<sup>50</sup> Narodowy Instytut Dziedzictwa ([http://www.nid.pl/pl/Dla\\_specjalistow/Badania\\_i\\_dokumentacja/zabytki-archeologiczne/archiwum-azp/](http://www.nid.pl/pl/Dla_specjalistow/Badania_i_dokumentacja/zabytki-archeologiczne/archiwum-azp/), access: October 20, 2016).

Table 2. Dictionary of attributes in the webGIS application and the database

Attribute name	Attribute values
chronology	EM – Early Medieval; LM – Late Medieval; M – Modern period
function	settlement function which comes from ASP source materials, i.e. glasshouse, point, track, village
pottery_pi	number of pottery pieces on the ASP site
pottery_de	pottery density on the ASP site

the Dutch colonization were entirely covered by forest, thus the deforested area is proportional to the number of farms. The ratio of the cleared forest to the number of farms should give an estimate of the acreage of forest which was grubbed by each farm, or its inhabitants, to be precise. The indicator varies spatially and ranges from 6,61 to 15,56 ha with the average at 11,07 and standard deviation at 2,41.

#### The buffers around the farms

The concept of rectangular buffers of different size encircling the farms arises from the colonists' settlement model in Nowy Tomyśl Plain. They were granted the lands in one plot, around a designated place for a farm. However, it is important to bear in mind, that the procedure applied only in case of newly founded villages, as the secondary locations (usually based on the German Law, then changed into Dutch privileges) usually did not change the existing field arrangement, and land division, which resulted in a different administrative organization of the community. The Dutch settlers, according to Władysław Rusiński's calculations, were usually granted  $\frac{1}{2}$  to 1 volok (Pol. *włoka* – a unit of land measurement) which directly translates into the area of 16–24 ha, though there some smaller farms can be found<sup>51</sup>. Therefore, we decided to assume four sets of buffers – 10, 15, 20 and 25 ha, which are supposed to depict the potential acreage of the farm with the fields or pastures.

#### Thiessen polygons

The Thiessen (or Voronoi) polygons represent the theoretical area of the influence of a phenomenon (defined as a point) by such establishing the borders that they lay exactly between the neighbouring points<sup>52</sup>. In our materials their function is twofold. Firstly, they were used to calculate the borders of the villages by modelling the potential spatial impact area for each farm. Secondly, they are useful in determining the potential forest area for each farm or at least, they can be used in calculations' verification by use of the spatial relations between the objects rather than buffers. The Thiessen polygons cannot overlap (in contrast to buffers), thus their spatial arrangement works in those places where the square model of land allotment proved inappropriate, or was subject to change at the beginnings of the 19<sup>th</sup> century.

#### The vegetation types

The reconstructed forest cover, except its extent and acreage, should be also ascribed to some type. Due to high degree of data uncertainty both acquired from the written and cartographic sources and the lack of palynological ones we resorted to establishing the type of the forest stands with a high degree of generalization: deciduous, coniferous, mixed type. The layer *Vegetation types* contains point data on the types of vegetation acquired from different sources, and consequently comprises three columns. The key is *InfoSource*

<sup>51</sup> W. Rusiński, *Osady*, p. 68–69.

<sup>52</sup> J. Urbański, *GIS*.

column, where the name of the source is stored, namely: UMTB from the first half of 19<sup>th</sup> century, topography map in scale 1:10,000 ([www.geportal.gov.pl](http://www.geportal.gov.pl)) as well as data from the *History and Geography Dictionary of Polish Lands in the Middle Ages*<sup>53</sup> (in the database as HGD). The *Type* column contains source information (translated into English) on the type vegetation type, while the *GeneralType* column is its generalization into the three aforementioned categories: deciduous, coniferous, and mixed forest, as well as wetland. The spatial resolution of the data depends on the type of the source – the majority coming from the current topographical map, the minority from the *History and Geography dictionary*.

#### Soils

The presented data is the result of vectorization and generalization of several sheets of soil-agricultural maps 1:100,000 developed at the Department of Soil Science and Soil Protection of the Institute of Soil Science and Plant Cultivation in Puławy. Among the information on the agricultural suitability and type of soil as well as the determination of the mechanical composition of the soil, data on soil types (*Soil type*) were obtained because it is of the greatest importance in determining the potential vegetation. In the area of the Dutch villages discussed here, there are usually two types of soil: muck mineral soil (middle part of the area) and sand soil. The database contains the code value from the map and the soil type name in Polish and English.

#### Potential natural vegetation

Potential natural vegetation is a hypothetical state of vegetation, which could be achieved by primary or secondary succes-

sion, if the human impact was eliminated. However, the term *potential natural vegetation* is not to be confused with the *primary vegetation* as it omits the time factor, and for the same reasons it doesn't correspond with a forecasted state of vegetation in the future<sup>54</sup>. The analysed area is dominated by pine forests: fresh (*Leucobryo-Pinetum*) and mixed (*Quercu-Pinetum*).

#### 4. Conclusions

The text presents the materials necessary to conduct the afforestation reconstruction in Nowy Tomyśl Plain gathered and visualised in WebGIS online application, and hereby described in terms of the method of acquisition, quality, and precision of data. The idea behind the publication of such materials was to familiarise the researchers of the former natural environment, both historians and geographers with the potential of joining the sources, and methodology of a historian and a geographer within a single research project. That is because the materials comprise both written historical sources and strictly geographical and cartographic ones. The other objective of the project – application-wise – was elaboration and preparation of the data in such a way that they can be presented in one WebGIS application and conjoined with a scientific articles by hyperlinks, which could direct the user to the map component from the level of text, pictures and other illustrations. We hope, that in the near future there will be more such publications, which will enable easier sharing and presentation of the source materials used in the research, verification of the research hypotheses and last, but not least, effective visualization of geohistorical spatial data. ■

*Translated by Paulina Wactawik*

<sup>53</sup> We used the online version of the dictionary: <http://www.slownik.ihpan.edu.pl/> (access: October 7, 2016).

<sup>54</sup> W. Matuszkiewicz et al., *Potencjalna roślinność*.



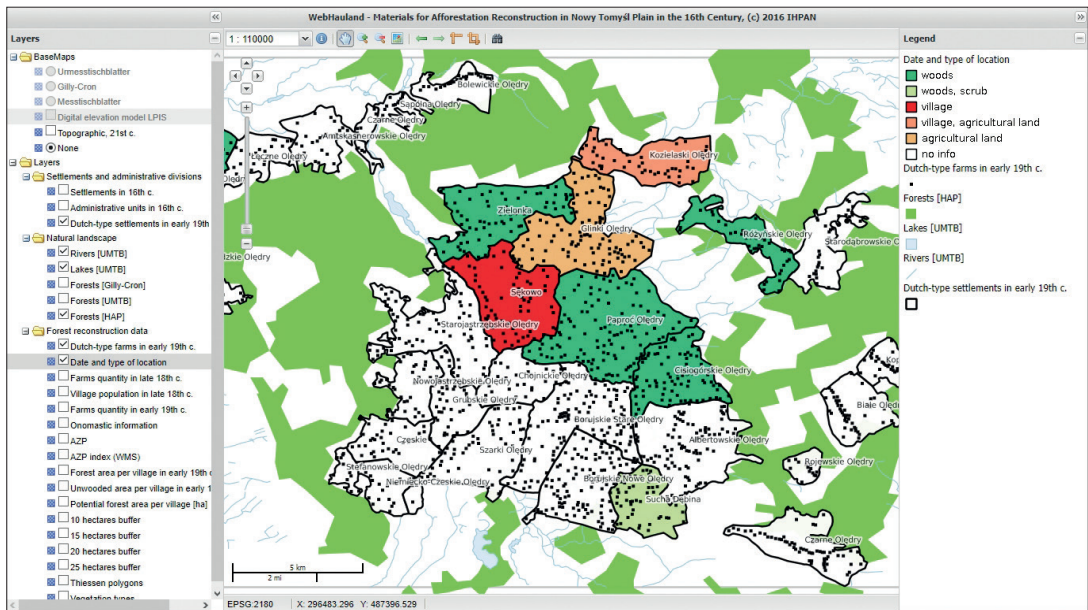


Fig. 4. WebGIS application available on AtlasFontium.pl

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## Summary

In the article, a process of elaboration of a database on afforestation reconstruction in Nowy Tomyśl Plain in the modern era was presented. The aim of the publication was to share the materials acquired from old and current maps and written sources, which are used in the reconstruction of the acreage, borders, and type of the forest in the area under scrutiny. It can be treated as a collection of metadata, in which the methodology of each thematic layer acquisition and elaboration is described. The elements in the database can be divided into four main thematic groups: Basemaps, Settlements and Administrative Divisions, Natural Landscape, and Forest Reconstruction Data. The basemaps comprise the Prussian georeferenced old maps: Gilly-Crons' map (1:50,000, the end of the 18<sup>th</sup> century) and maps in scale 1:25,000: *Urmesstischblätter* (first half the 19<sup>th</sup> century) and *Messtischblätter* (second half of the 19<sup>th</sup> century). In order to graphically connect the historical to the current data, the topographical map and a Digital Elevation Model acquired from Geoportal were used. The application also includes the settlements, administrative

divisions: from the 16<sup>th</sup> century (on the basis of the last HAP volume) and the 18<sup>th</sup> century (reconstructed for the purpose of this project on the basis of the old maps and written sources). In the Natural Landscape thematic group, there is data on hydrography and afforestation dating back to the end of the 18<sup>th</sup> century (Gilly-Cron's map) and the first half of the 19<sup>th</sup> century (*Urmesstischblätter*). The crucial objects from the perspective of the conducted analysis are those on afforestation. Their choice was based on the potential to reconstruct the extent, borders, and types of forests in the said area in the 16<sup>th</sup> century. Thus, worth mentioning are: data on Dutch settlement dynamics in the 18<sup>th</sup> century, potential forest area per a village, results of Archaeological Survey of Poland, onomastic information, or even the information on the vegetation type acquired from the written sources, and old and current maps. All the above can be analysed in the application, though they can also be downloaded if the need arises in the form of a geodatabase (\*.mdb) and analysed further by the more advanced users. ■

**Keywords:** historical geography, retrogressive method, Dutch-type settlement, Nowy Tomyśl Plain, environmental history

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