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Between retrogression and progression – a proposal for a new method to recreate the historical building layout of settlement units

Abstract. The use of cartographic sources and methods are the basic tools of historical geography. One of the main research trends in this field is the analysis of the spatial layout and number of old settlement units. The confrontation of maps with historical data allows the drawing of a town's area at a certain time to be studied. The retrogression (R) and progression (P) methods that are currently used are imperfect and the model created (map) is usually incomplete and its reliability is limited. In the author's opinion, the joining of retrogression and progression (a new method; combined – K)[1] increases the quality of cartographic reconstruction of natural and cultural landscapes. The use of basic mathematical methods from the scope of set operations means the component reliability of the researched cartographic model can be varied because the common part of the retrogression and progression cartographic model represents mutual verification of source data. Quantitative effectiveness assessments of retrogression (R), progression (P) and the combined method (K) can be made for countable elements (e.g. buildings). As part of the conducted study, the effectiveness of separate methods was calculated: R = 76% for retrogression, P = 59% for progression and K = R ∪ P = 85% for the combined method. The mutual verification of the methods (R ∩ P) included 45% of residential buildings. The author describes the proposition of a new method and the course of verification research.

Keywords: settlement reconstruction, cartographic methods, progression, retrogression, historical GIS, Bychawa

1. Introduction

The changes in geographical space over time requires the use of geography and cartography achievements to supplement historical research methods. The need for the complete understanding of events, phenomena and processes occurring in historically determined spatial realities (often substantially different from today's) is the foundation of established historical geography as a separate, interdisciplinary research trend[2]. Archival map analysis – especially of early topographical maps[3] – is one of the methods of reconstructing past geographical environments. Materials and cartographic methods are of the greatest importance in the reconstruction of the spatial layout of settlement units. The degree of coverage of archive maps of geographical space is varied, and the cartographic material assessment depends on many factors. In the 1920s, S. Arnold (1929, p. 115) wrote:

[1] The concept of the combined method (K) was proposed in the author's doctoral thesis (J. Kuna 2017), however the following book publication (J. Kuna 2018a) was addressed to the local community and the methodology was only briefly mentioned. The purpose of this article is to present the new method in greater detail. Together with the verification process, the combined method may contribute to other research.

[2] This notion is discussed by many authors, e.g. S. Smolka 1880; S. Arnold 1929; B. Konopska 1994; B. Szady 2013; J. Tyszkiewicz 2014; H. Rutkowski 2018, 2019.

[3] The most popular studies of the last decade are, among others: A. Czerny (ed.) 2015; B. Konopska, J. Ostrowski (eds.) 2014; J. Plit 2016; B. Szady 2008, 2013.

"The last category of settlement history is cartographic material – maps and plans. Modern day maps can be only a technical help in compiling settlements; they can be a source in one issue only (and only if they are prepared in large scale) in settlement topographic locations studies. [...] Plans of towns and villages, as sources, are of much greater importance because, as was mentioned before, the study of settlements' shapes and their territorial development is based on them."

Cartographic documentation of big and old cities is usually extensive. The oldest preserved cartographic archives of large, Polish urban areas are from the 16th and 17th centuries (A. Bartoszewicz, H. Bartoszewicz 2013, K. Nieścioruk 2007). Plans and detailed maps of small towns were rarely prepared and, in the historical sense, not until much later on. In the historical context of Polish lands, four periods of an increased amount of detailed cartographic monographs can be mentioned:

a) the turn of the 18th and 19th centuries – regulating town plans (the studies of the *Boni Ordinis Committee*) from the era of Stanisław August Poniatowski and the first military partitioners' maps;

b) the second half of 19th century – Austrian and Prussian cadastres, the second phase of military partitioners' maps (Prussia, Austria), maps of villages in relation to property rights, and degraded urban settlements (Russia);

c) the turn of the 19th and 20th centuries – detailed military topographical maps (all partition territory);

d) the 1920s and 1930s – detailed Polish military topographical maps of MGI (Military Geographical Institute).

The 19th century cadastre and detailed military topographical maps for the area of former Austrian and Prussian partitions were the subject of extensive research by, among others: A. Konias (2000, 2001), J. Wolski (2000, 2001), M. Sobała (2012) and also teams of the *Polish Historical Towns Atlas* (HTA) from Kraków, Toruń, Wrocław or the *Historical-Topographical Atlas of Silesian Towns*[4]. The concept of systematic historical studies concerning the urban spaces of former Russian partitions has not been fully formed yet.

In the cartographic assessment the 19th century, regulating city plans and property rights maps are varied sets according to scale, the scope of content, the detail of drawing, etc. (M. Lewandowska, M. Stelmach 1996). Single items are an excellent source for particular analytical studies; however, it is hard to assess the entity as the foundation of synthetic studies. Scattered throughout the State Archives and various public institutions, they are often limited within proprietorship (outdated for a long time) – they make hard to reach, incomplete (spatially) and incoherent (methodically and chronologically) research material[5]. Detailed topographical maps prepared by the partitioners' countries are much more coherent in all categories mentioned (taking into account the comparison between maps of different partitions also – T. Panecki 2015, 2017; W. Ostrowski, I. Karsznia, T. Panecki 2018). Simultaneously, thanks to the activity of internet repositories, this material is available, relatively complete, easier for computer processing and more suitable for conducting systematic comparative works[6]. Taking into consideration counter-copies prepared by MGI in the 1920s and the 1930s, we can acknowledge full coverage of detailed topographical maps of Poland in the turn of the 19th and 20th centuries.

Unfortunately, during the interwar period, only 35% of updated 1:25,000 detailed maps from the area of the Second Polish Republic were published (J. Kuna 2018)[7]. The lack of

[4] Vide *Polish Historical Towns Atlas* (http://atlasmiast.umk.pl/); *Historical-Topographical Atlas of Silesian Towns* (https://www.herder-institut.de/projekte/laufende-projekte/historisch-topographischer-atlas-schlesischer-staedte/atlas-miast-slaskich.html).

[5] Progressive digitalization of archive sources and growing stores of digital repositories (e.g. www.lac.lublin.pl, www.rcin.org.pl, www.szukajwarchiwach.pl) give hope for more common access to systematized, multiscaled topographical sets of cartographic studies in the form of good quality scans. However, this process is slow because of enormous stores and limited technical and financial possibilities.

[6] Vide Maps Archive of Military Geographical Institute from 1918 to 1939 (http://www.mapywig.org.pl), David Rumsey Map Collection (http://www.davidrumsey.com/), Mapire – The historical map portal (http://www.mapire.eu/), Mapster – archival maps of Poland and Central Europe (http://igrek.amzp.pl/), Digital Repository of Science Institutes (http://rcin.org.pl/).

[7] In this publication, an updated index of detailed map sheets at the scale 1:25,000, which are available on Mapster, were placed: 'normal' sheets published by WIG were sectioned, counter-copies of partitioners' maps and 'partially compiled' by MGI – completed and published by the order of

detailed topographical maps is a serious gap in the source documentation and precludes tracking the changes of the urban structures of towns in the period of their dynamic development. The tragic experience of the Second World War, the Holocaust, 'the liberation' by the Soviet Army and system changes caused irreversible transformations in many towns. Because of the devastation of information sets, reports concerning the appearance of pre-war towns are scarce (E. Przesmycka 2001). Taking the circumstances mentioned into consideration, recreating the spatial layout of interwar towns of the central and eastern part of the Second Polish Republic is a demanding but also interesting research task.

According to the present-day perspective – 90 years after the publication of S. Arnold (1929) – it is worthy of note that topographical maps (partitioners' and Polish MGI's – if they are available) carry a crucial source value for the lands of the former Russian Partition: first, because of the far more serious changes of the towns' spaces in the 20th and 21st centuries than in earlier times; secondly, by virtue of turbulent historical events that took place in this part of the world in the middle of the 20th century; thirdly, because of the lack of alternatives in the form of detailed and systematic cadastres, available from the 19th century for other parts of the country.

2. Previous cartographic methods: retrogression (R) and progression (P)

Studies of the cartographic recreation of the spatial layout of towns are conducted by means of retrogression and progression. **The method of cartographic retrogression (retrogressive method – R)** is a standard method of geographical and historical research (S. Arnold 1929; H. Szulc 1964, 1984, 1995; M. Kiełczewska-Zaleska 1976; J. Plit 2014, 2016). It is based on the creation of a historical space model by means of eliminating documented space changes from the cartographic material compiled in a later period (e.g. from today's material). The retrogression method has been formalized and introduced to the canon of historical geography methods in the middle of the 19th century (B. Konopska 1994). In S. Arnold's assessment (1929, p. 115) "... in cultural landscape study – the retrogressive method always comes to the foreground, starting from the most recent times, those for which we possess the most complete historical data, and then going backwards, exploring younger settlement layers until we reach the oldest ones. [...] Retrogression is the only possible method for historical times."

The advantages of this method are the precision of localisation, the larger comparability of modelled image with the present-day topographic situation and the greater probability of finding detailed source materials. The lack of the possibility of recreating blurred changes is one of the disadvantages, i.e. changes accumulating on the same space segment in analysed time (e.g. the building time of a structure is known, the presence of other structures in the past is also known, but their purpose remains unknown).

The cartographic progression method (progressive method – P) is based on creating a historical space model by complementing an older map (made earlier) with documented space changes between period of establishing the source map and the studied historical period. In the cartographic sense, progression is an analogical process to a map update, used for the revision of the archival map. Its advantage is the ability to make corrections in accordance with chronological changes, i.e. following the sequence of events, which becomes particularly useful in the reconstruction of subsequent processes (e.g. settlement expansion). Finding starting cartographic material with details that enable the precise determination of the initial state (documenting the state before changes) can be a problem. Because of this the use of progression in settlement studies is relatively rare; in the Polish literature this notion was mentioned by M. Kiełczewska-Zaleska (1976) and H. Szulc (1995), and recently also by T. Figlus (2012, 2016), R. Szmytkie (2014) and D. Mikulski with E. Raszeja (2017).

"Progressive methods, based on passing from older to younger phenomena in order to explain the origin of new elements, were used in this study only to a small extent, just in the case of villages established most recently. The use of progressive methods is not frequent

occupational authorities. Vide J. Kuna 2018, *'Partially compiled' maps 1:25,000 by Polish Military Geographical Institute (1919–1939)*, "Polish Cartographical Review" Vol. 50, no. 1, pp. 31–46.

because, in order to follow the whole process of settlement development, a sufficiently rich starting point and final material have to be maintained. The boundary between the use of progressive and retrogressive methods is usually the turn of the 18th and 19th centuries" (H. Szulc 1995, p. 23).

The contrast between maps and other documents and descriptive sources enables the partial reconstruction of a settlement layout at a certain moment. Unfortunately, retrogression and progression methods are imperfect, the model created (a map) is usually incomplete and the credibility of the achieved results can be questioned.

the case of proper attribute coding (tab. 1) in the form of Boole's algebra equations. Because of this, in the following part of this article, notions concerning operations on sets and logical functions are treated interchangeably: geometric sum (∪) = logical alternative (OR), geometrical product (∩) = conjunction (AND), geometric difference (\) = exclusive or (XOR), geometric disjoint (¬) = logical negation (NOT)[8].

The content of a new cartographic model (K map) is created as a result of the combined implementation of both methods – it is the sum of content models based on retrogression and progression methods (R ∪ P). The credibility of the created model K is not homogeneous. The

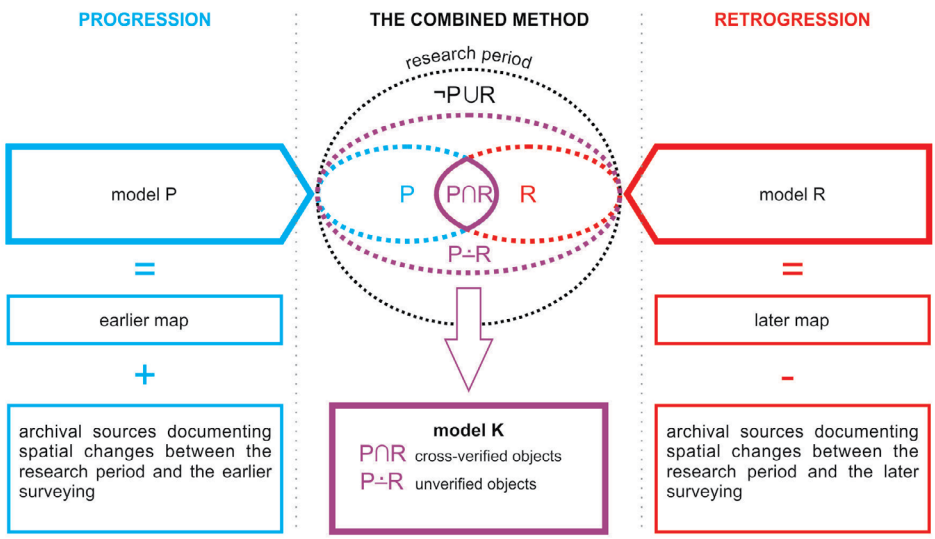

Fig. 1. The scheme of cartographic reconstruction with the combined method. The 'K' model consists of joined models 'R' and 'P' (the sum 'R∪P'). The common part of 'R' and 'P' models ('R∩P') is mutual for both retrogression and progression, therefore it is the area of increased reliability of the reconstruction (positive cross-validation). The 'K' model does not fill the whole reality, there is a part that is impossible to be reconstructed with retrogression or progression (denied sum of 'R∪P') (J. Kuna 2017)

3. A new method – combined (K)

The assumption of a **combined method (K)** was based on the contrast and mutual verification of retrogression and progression methods (fig. 1). The crucial element of this method is the ability to implement it in Geographical Information Systems (GIS) in the form of operations on spatial data sets (geometrical), and in created cartographic content can be divided into three subsets:

[8] It is necessary to note the parallel functioning of many identical mathematical operations of notation systems. Accessible explanation of logical equations and set operations can be found in https://en.wikipedia.org/wiki/Boolean_algebra and https://el.us.edu.pl/ekonofizyka/index.php/Elementy_logiki_i_rachunku_zbior%C3%B3w

Tab. 1. The GIS layer attribute coding scheme used for the reconstruction of the historical settlement of Bychawa (J. Kuna 2017)

No.	Name	Type	Value
1	Object ID	auto-numbering	numerical from 1 to 3289
2	shape	geometry	point (x,y)
3.	name	text	unique values
4.	range	true/false	0 – outside the map area 1 – inside the map area
5.	town (1938)	short integer	0 – no data 1 – Bychawa 2 – Grodzany 3 – Leśniczówka 4 – Podzamcze 5 – Wandzin 6 – Wola Mała 7 – Zadębie 8 – Marysin 9 – Wola Bychawska
6.	year_1918	true/false	0 – absent 1 – present
7.	year_1938	true/false	0 – absent 1 – present
8.	year_1957	true/false	0 – absent 1 – present
9.	year_1978	true/false	0 – absent 1 – present
10.	year_2016	true/false	0 – absent 1 – present
11.	function (1938)	short integer	0 – unknown 1 – residential 2 – utility 3 – other
12.	street (1938)	text	unique values
13.	confirmed	true/false	0 – no 1 – yes
14.	individual	true/false	0 – no 1 – yes
15.	retrogression	true/false	0 – no 1 – yes
16.	progression	true/false	0 – no 1 – yes

1) model content P unconfirmed in R model, i.e. the $P \setminus R$ difference,

2) model content R unconfirmed in P model, i.e. the $R \setminus P$ difference,

3) verified content of two models, logical conjunction, i.e. the product $R \cap P$.

The separate use of progression and retrogression methods requires the study of P and R models. In the combined method both of these models are indirect links for K model creation. The proposed solution is not perfect – the $R \cup P$ sum does not guarantee a hundred per cent filling of a historical space. There is an unmarked area left $\neg(R \cup P)$. Despite that, the implementation of a combined method appears to be more advantageous than the use of retrogression and progression individually. The combined method should, to some extent, join the advantages and eliminate the disadvantages of both current methods.

The assessment basis for the effectiveness of progression, retrogression and combined

methods was the case study of the reconstruction settlement layout of a chosen town in a certain year (J. Kuna 2017). It was assumed that the study would consider late 1930s, a town presented on an Polish MGI's tactical map at 1:100,000 scale, but without analogical detailed map at 1:25,000 scale. Bychawa, a small, moderately old town (town charter in the 16th century) in the Voivodship of Lublin, was chosen. In the late 1930s the population of the town was around 4,000 inhabitants (with a large number of Jews) and it housed the office of district authorities. 346 dwelling houses of a typical spatial layout (a densely developed market square and a street beside it, the agricultural character of the town outskirts – fig. 2b) comprised the buildings of this town. The history of the town's spatial development is typical according to the scale of the region[9]. The most important criterion of choice was access to cartographic documentation (plan, detailed topographic map) from the preceding First World War period (fig. 2a) and analogical documents (plan, map, aerial photograph) from the turn of the 1950s and the 1960s (fig. 2c).

In the research study (J. Kuna 2017), a main hypothesis was formulated: *every method of cartographic reconstruction enables the retracing of the Bychawa settlement arrangement in 1938 to a larger extent than 50% of residential buildings; combining methods increases the effectiveness of the reconstruction in a crucial way.* The main hypothesis was supplemented by partial hypotheses:

1) the progression *method enables the recreation of Bychawa's building layout in 1938 to a larger extent than 50% of residential buildings;*

2) the retrogression *method enables the recreation of Bychawa's building layout in 1938 to a larger extent than 50% of residential buildings;*

3) *the* extent *of recreating Bychawa's building layout in 1938 by the combined method is far larger than by the progression and retrogression methods separately;*

4) the part which was recreated both by progression and retrogression methods concerns more than 50% of Bychawa's residential buildings in 1938.

4. Research conduct

The case study was preceded by queries in archives and libraries, the *in situ* inventory and consultations among the local community. Extensive regional literature, and cartographic, photographic and architectural documentation (detailed list in J. Kuna 2017 and 2018a) were gathered. The digitalization of archive materials was of great importance for mastering the abundant source material. The use of the geomatic method of research was crucial workshop support (Z. Kozieł 1997). The ability to screen freely magnified or downscaled document fragments substantially facilitated their analysis and comparison. Creating a database model in GIS environment and georeferencing of raster archives solved the problem of the inconsistency of mathematical foundations for the majority of cartographic sources (J. Kuna 2015). Text and digital information, the logical values 0/1 stating if certain objects occur in source maps and the established reconstruction method were typed into the attribute chart (tab. 1). The coding of indicated value with the use of numerical formats facilitated the creation of spatial and statistical analysis.

Database space reference was based on a current 1:500 master map. The master map was used for digitalization of residential buildings existing in 2016 and for selecting old buildings. Digitalization and comparative analysis of calibrated maps, photographs and plans enabled the marking of objects which repeat on other, older and older source materials (J. Kuna 2018a). Location of buildings existing in 1978, among which many were marked out for preservation in the 1980s and are now non-existent[10], was determined based on an objects of interest map made by Voivodship Conservation Officer (1984, fig. 2d). The digitalization of aerial photographs (fig. 2c) enabled the number of buildings in 1957 to be determined and established the place of many objects documented in old photographs. The digitalization of a settlement

[9] There is an abounding set of historical and regional publications concerning Bychawa – see the full list in: J. Kuna, 2018, *Bychawa 1919–1939: cartographic reconstruction of the town*. The interwar period was poorly researched until now; also there were not enough extensive studies describing the town's history from the perspective of space changes (the only current study of this type – historical and urban planning study by P. Sygowski (1984) – is available as a typescript in The Public Library in Bychawa).

[10] The city map appeared in: P. Sygowski, 1984.

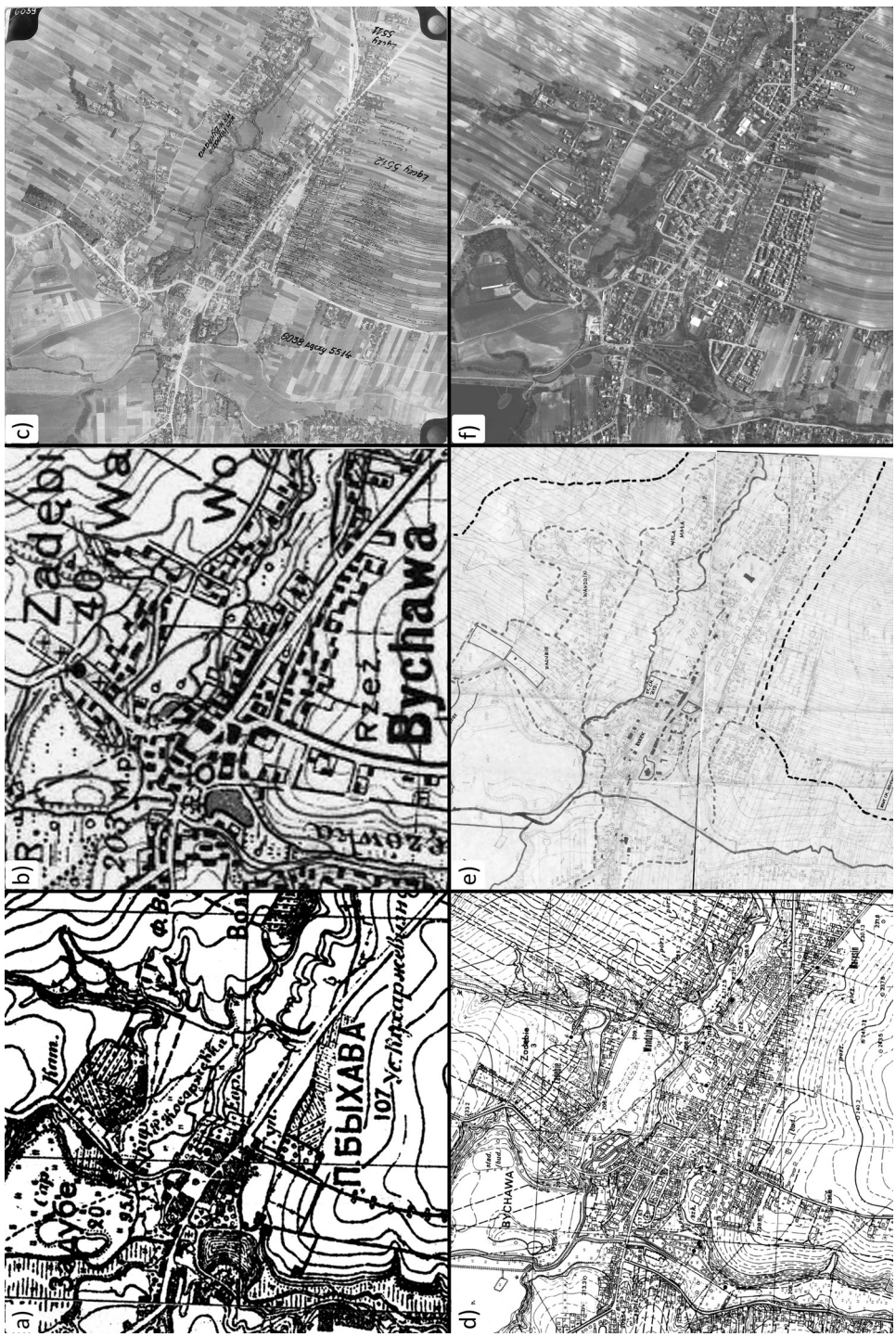

Fig. 2. Major cartographical sources – a) half-verst map from 1888 (a counter-print by the Polish MGI), b) a tactical map by the MGI from 1937, c) an aerial image from 1957, d) a topographical map from 1976, e) the restorer's city map from 1984, f) an orthoimage from 2012 (all sources rescaled to 1:25,000)

1:2,100 city map (from 1897), Russian 1:21,000 topographic survey (from 1888 in German reprint in 1915 – fig. 2a) and architectural sketches from 1880 to 1918 enabled the initial situation for progression method to be established. After adding objects marked on architectural plans and photographs from 1919 to 1939, objects which were in the town's settlement range on a 1:100000 MGI tactical map (fig. 2b) were analyzed in the database. The database consists

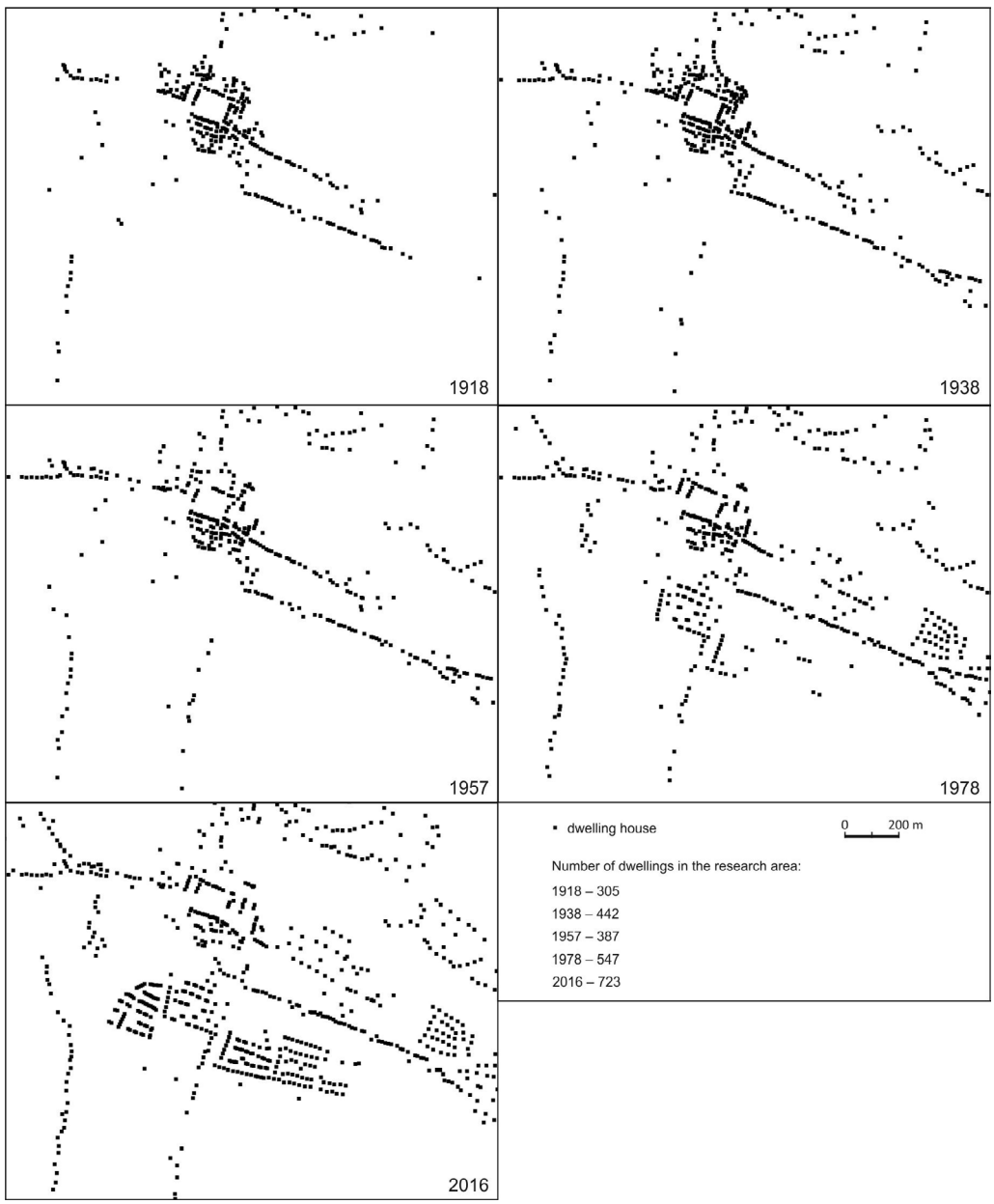

Fig. 3. Dwelling houses in years 1918, 1938, 1957, 1978 and 2016 (J. Kuna (2017)

of 3,289 buildings which document settlement changes in Bychawa in the 20th century, in more or less equal time intervals (fig. 3). Given values concern the total amount of buildings for a presented area, regardless of the town's boundary changes.

The process of recreating Bychawa's boundaries in particular historical times goes beyond the limits of this article; however, it is worth mentioning that source materials were not fully unanimous. 346 objects (fig. 4) were selected from the studied area, which corresponds to the number of dwelling buildings described in the MGI tactical map. The error of underestimating/overestimating concerned three objects placed on the outskirts of town and it was marginal (<1%). After completing the research, verification was carried out concerning the results obtained by various methods.

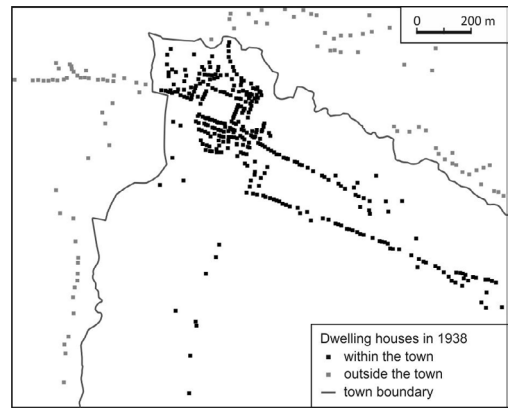

Fig. 4. Dwelling houses within administrative boundaries of the town in 1938 (J. Kuna (2017)

5. Methods effectiveness verification

In the results of the implementation of retrogression, progression and combined methods, specific numbers of residential buildings were gathered. The basis of partial hypothesis verification was the comparison of those values with data occurring in research studies, regional studies and archive documents. An important source used to verify results was the list of houses placed in certain streets of the town in 1941, which was produced by the order of occupational authorities[11].

The initial assumption that the separate use of retrogression and progression methods enables only partial reconstruction of Bychawa's building layout in 1938 was found to be correct. The retrogression method was used for determining the localisation of 264 (76%) residential buildings (fig. 5, part R). The progression method was used to determine the localisation of 187 houses, i.e. 54% of houses (fig. 5, part P). This is 80 more than the number of houses documented on the half-verst map from 1888, but it still does not compare to the increase in the number of houses by 1939 (239 houses). Because of the fragmentary photographic documentation and the lack of dwelling house projects from this period, the capabilities of the progression method were used only to an adequate degree.

Combining retrogression and progression methods enabled the localisation of 295 residential buildings to be determined (fig. 4, part $R \cup P$), which is 85% of the number of houses in Bychawa in 1938. The common part of the sets (fig. 5, part $R \cap P$) has 156 houses – which means that 45% were identified by the two methods. This is less than half of the dwelling houses in the town in 1938 but, still, it is more than a half of all the buildings that it was possible to reconstruct. During the reconstruction of Bychawa's settlement from 1938, the retrogression method was found to be more effective than the progression method. The number of dwelling houses determined by means of the retrogression method and not confirmed by the progression method amounted to 108 houses (fig. 5, part $R \setminus P$ – 31% of objects). The number of residential buildings determined by means of the progression method and not confirmed by the retrogression method amounted to 31 (fig. 5, part $P \setminus R$ – 9% of objects).

The localisation of 51 houses (15%) was not successfully determined using any of the methods. Thanks to the list of houses (*Orientierungsskizze* 1941) it was possible to narrow the localisation of unknown houses to particular streets. Streets that were the least successfully reconstructed are those which were inhabited mostly by Jews in the interwar period and remained as slums in the inhabitants' memories.

[11] *Orientierungsskizze der Siedlung Bychawa*, scale about 1:10,000, manuscript, Bychawa 1941; source: APL Kreishauptmannschaft Lublin-Land, sign. 135. k. 48.

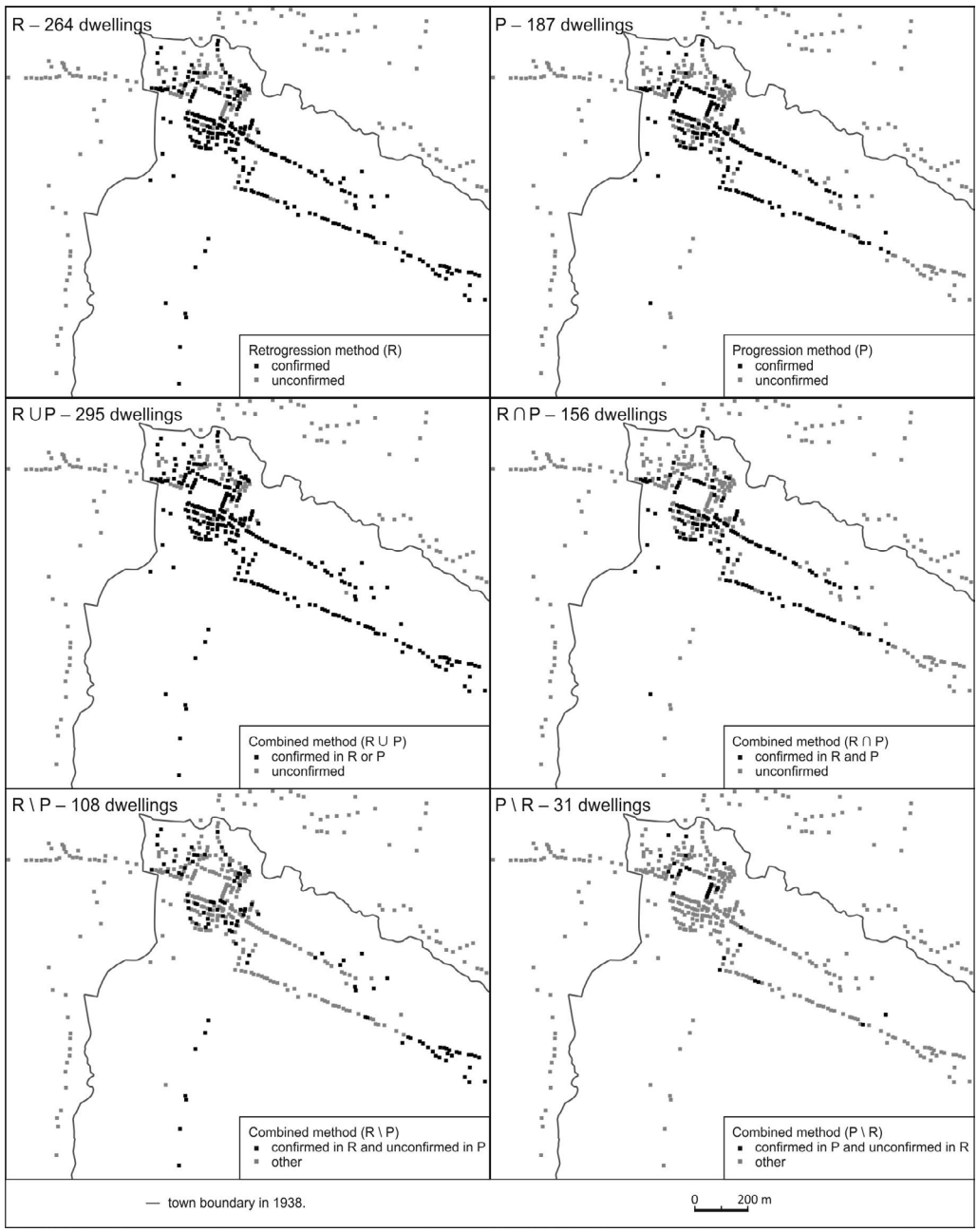

Fig. 5. Dwelling houses in 1938. The comparison of results achieved with retrogression, progression and combined methods (J. Kuna 2017)

Fig. 6. Bychawa, the western face of the market square (poorly documented): a) the photo from 1915–1918 (found in Österreichisches Staatsarchiv in November 2017); b) the virtual mock-up *Wirtualna Bychawa 1938* (finished in April 2017). The reconstruction achieved 83% (5 of 6 buildings)

Those parts of the city suffered the most during German occupation, the ghetto liquidation of 1943 and fights of 1944 (J. Kuna 2018 and others)[12].

The case study resulted in hard numerical data providing the basis for the positive verification of the main hypothesis and the three partial hypotheses. The legitimacy of the application of the retrogression method, the progres-

[12] Compare footnote 11.

sion method and also the combined method was confirmed. The results did not enable the positive verification of the fourth hypothesis in comparison with the total amount of residential buildings in the studied period; however, in relative terms, 59% of reconstructed objects found mutual verification in retrogression and progression. The study effectiveness was partially confirmed, *post factum,* thanks to the discovery of a pre-war photograph of the west face of the market square, poorly documented until now.

6. Summary

The lack of detailed maps and particular historical circumstances mean that the reconstruction of a pre-war Bychawa's building layout was a difficult research task. The nature of the cartographic source material – heterogeneous, incomplete or too generalized – was of the greatest importance. The effectiveness of the results achieved by means of retrogression (76%) and progression (54%) methods, to a large extent, depended on the accessibility of supplementary materials (photographs, architectural project, sketches). Of course, the established model (map) of Bychawa in 1938 is imperfect – the location and shape of 85% of residential buildings were determined.

The processing of the cartographic model (map) of Bychawa in 1938 has provided some new knowledge regarding the studied town's space. The research conduct was finished by the publication of the town's monograph (J. Kuna 2018), a series of maps showing the space changes of the town in the 20th century (as attachments to the book) and a computer animation (available on YouTube)[13]. The author hopes that various forms of the presentation of results will become a point of reference and inspiration for further studies – which would supplement defects or help to verify some observations.

The author believes that the most important achievement of the presented proposition (combined method – K) is its **universal character** and the prospect of its use in studies of other towns, historical periods or notions at a larger spatial scale. The ability to verify mutual source materials and the quantitative assessment of settlement development reconstruction degrees shifts the way this academic problem is perceived – from humanistic to scientific.

The last, but also very interesting notion connected with geographic and historical studies of small towns is the issue of community participation. During the research studies, a blog – *Wirtualna Bychawa 1938 (Virtual Bychawa 1938)* – was founded on social media, where progress and small discoveries were reported 'live'[14]. The results of the sociological experiment were beyond expectations. The blog became the main axis of communication with the local community and was followed by a couple of thousand regular readers – including from abroad. Shared posts recalled memories, provoked discussion and prompted new materials to be sent by the readers. Among balanced and factual argumentation, personal recollections supplemented with photographs from home collections were present. The map of interwar Bychawa is, to some extent, a collective study of the community to which it directly relates.

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[13] Wirtualna Bychawa 1938 – computer animation (https://www.youtube.com/watch?v=2xhYW5OWTPs).

[14] Wirtualna Bychawa1938 – community project (http://www.facebook.com/Wirtualna.Bychawa.1938/).

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