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Labels on coloured tactile maps (typhlomaps) – the Polish experiences

Abstract. The author presents the problems associated with geographical name conventions and labels on coloured tactile maps in atlas-type publications for the blind and visually impaired, based on the author's many years of experience. The detailed description of the 'keys' system and Braille 'abbreviations' which Polish cartography uses in this type of works shows the benefits of using the system in the editing of map series. A framework of logical and intuitive 'abbreviations' presents many possibilities and makes maps easier to read. The system for connecting names of a particular 'family' of terms by using a two-letter abbreviation preceded by a unique 'key' should be a fundamental principle for creating sets of Braille 'abbreviations' for use in a given work. The author also highlights the need to use exonyms, since Braille's basic alphabet has none of the diacritic characters which typify various languages, which hinders the correct transcription of certain names.

The proposed system for constructing 'abbreviations' and 'keys' may also be used effectively in individual town plans and maps to improve the communication of information. The comprehensive structure of this system also makes it easier to search through indexes of 'abbreviations' and their explanations.

All the described elements have an impact in raising the practical value of tactile maps.

Keywords: tactile map, typhlomap, typhlocartography, 'keys' and 'abbreviations', Braille alphabet

1. Introduction

The issue of labels on maps for the blind and visually impaired has not been a subject of great interest to cartographers to date. Looking at the problems encountered in choosing geographical names on traditional maps, it would seem that such interest is essential in relation to tactile maps as well. Many years' experience has shown that there are many problems, issues to be clarified, and matters needing to be ordered and even standardised.

It might seem that the problems would be similar to those difficulties which we encounter in elaborating maps for sighted people, which is to say issues of geographical names, or the variety of ways of placement of the names on maps, but it is not. The following issues may contribute to the discussion around the introduction of standardised rules for the use of object labels, in particular in colour atlases of general geographic tactile maps. The issue of the labels on city maps, i.e. larger scale and more detailed publications, is far better defined and organised (P.K. Edman 1992), but some of the proposals presented here for smaller scale maps may facilitate the reading of tactile maps and the memorisation and inter-associating of layers of geographical names.

To avoid ambiguity from the outset it is important to explain the concepts and terms used in the following text. This will help in the understanding of the issues presented.

In much of the non-English literature (including the Polish), the equivalent word to 'tactile' is the same as that used to mean 'touch'. This latter has expanded in meaning due to various technological innovations, such as touch screens, touch monitors and smartphones, which have become part of everyday life. Moreover, of the two meanings of 'touch', it is the technological sense which is most readily called to mind, rather than the meaning related to the visually

impaired. It would seem useful to distinguish products read by touch or using touch to communicate from this ever-growing category of 'touch' technologies and 'touch' objects.

In the 1980s, and in communist bloc countries, in particular, the terms 'typhlomap' and 'typhlocartography' came into use. The source of both terms has its origins predominantly in the literature of former Czechoslovakia and, interestingly, they are still used in scientific works and among the visually impaired. Some scientists nonetheless treat these terms as archaic and lacking modernity.

Both have the distinctive common root 'typhlo' (from Greek typhlos – blind) which is used in many names associated with the environment of the visually impaired. And so it is with typhlology, the body of knowledge of psychology, medicine, pedagogy, sociology and technology which is of use to the blind in their education, upbringing, therapy and rehabilitation, or to people dealing with the blind. Typhlology has defined terms (again, more commonly in the countries of the former communist bloc) which unambiguously describe their referent, and thus we have 'typhlopedagogy', 'typhlopsychology', 'typhlotheraphy', 'typhlo-informatics' and 'typhlopodcast', and others including 'tactile graphics' to which belong tactile maps. This linguistic construction also gave rise to 'typhlomap' and 'typhlocartography'[1]. The propagation of these terms will allow them to be added to a family of expressions with the common prefix 'typhlo', imbuing them with a uniqueness in the fields of both cartography and special pedagogy.

This paper will mainly use the terms 'coloured tactile map' (M. Olczyk 2014), 'tactile map' and 'typhlomap'[2].

Do concepts expressed with the 'typhlo' root also relate to publications for the visually impaired? Yes, since the decided majority of tactile publications which use the Braille alphabet are also read and used by people with impaired vision and the sighted (teachers, carers).

Works without touch-read content which are intended for visually impaired recipients include large-print publications or adaptations of ready publications, and in the author's opinion, such publications should not be counted as 'typhlo-publications'.

In the past 15 years, Polish cartography has been expanded with several atlases of our country, as well as of the European continent and the entire Earth. These publications have made it possible to prepare the principles for implementing labels and names in content-rich maps and, more importantly, to test them in practice in schools over many subsequent years. The proposals presented in this paper, therefore, have the value of being tested solutions.

Of the published atlases, the *Atlas geograficzny Europy* (Geographical atlas of Europe), published in 2006, was of particular importance. It was noticed and appreciated by various competitions and scientific bodies, including internationally, being awarded, among others, first prize in the 'Other' category at the cartographic exhibition of the 13th International Cartographic Conference in Moscow, 2007[3]. The atlas was created – as is every typhlopublication – with the participation of many specialists proposing solutions implemented to date in tactile publications. The synthesis of the knowledge and experience of typhlopedagogs, typhlologists, typhlocartographers and blind and visually impaired people allowed the development of several important principles which were then successfully used in subsequent tactile publications for the blind and visually impaired in Poland (M. Olczyk 2014). The *Atlas geograficzny Europy* (Geographical atlas of Europe, 2006) became an important publication which can only be appreciated from the scientific perspective now that the developed methods,

[1] Typhlocartography is the branch of cartography concerned with maps for the blind and visually impaired; it analyses the way in which the visually impaired can familiarise themselves with maps, studying the differences between reading by sight among the visually able and those with impairments, as well as reading by touch. This research and observations result in principles for generalising elements of content, the design of symbols, the selection of appropriate cartographic methods, the layout of labels, the means of describing map content, and other factors which impact on the readability of maps for the blind and visually impaired (M. Olczyk and M. Polak 2010).

[2] Other, less commonly terms are also used and associated with distinct printing technologies of methods of use for maps, such as 'embossed map', 'plastic map', 'relief map', 'spatial map', 'Braille map', 'colour-tactile map', 'visual-tactile map' or 'colour-plastic map'.

[3] The Atlas has also been awarded: second prize in the 'Best Atlas' category by the International Map Trade Association (IMTA) in 2006; second place in the category 'Other maps, handy or wall' for the map of the European Union from that atlas in the 'Map of the Year 2006' competition organised by the Association of Polish Cartographers.

graphic solutions and principles for describing objects have proven itself effective in a series of publications. It was particularly important to develop 'abbreviations' and 'keys' for Braille descriptions for more than 1000 geographical labels, which forced many changes in relation to the solutions used at that time which proves its universality and usability.

2. Labels on maps

The job of the cartographer is to develop a map which legibly communicates its potential informational capacity (L. Ratajski 1977). This is hard to unambiguously define. It comprises the graphic capacity, i.e. the number of symbols for a given surface area, and the informational capacity, which is largely dependent on the recipient, his/her intellectual capacity and – in the case of typhlomaps – perceptual capabilities in particular.

The labels are an important component on a map. First, they identify objects presented on the map. In order to do so, the graphic properties of the printed word must be exploited in an informed manner by selecting the appropriate parameters. Choice of font, its size and colour, and letter- and word-spacing facilitate the reading of a map, and make it possible to determine the types of objects represented, their linear extent (e.g. a system of mountain ranges) and their spatial extent (e.g. labels for regions, countries, seas and oceans). The size of labels and their visual weight order the nature of objects and geographic phenomena (W. Ostrowski, P. Kowalski 2004). This font property can be used to rank the presented objects. One example is town labels, where font size distinguishes the town size (by population size or functional range). In topographic maps, the use of uppercase letters ('caps') in a place name indicates a town or city, while lowercase letters (text) indicate a village. Alignment of geographical names with parallels tells the reader how the map is oriented. The placement of a geographical name also bears important information about the position of, for example, a coastal town, which is labelled on the body of water, or riverside objects, which are labelled on the appropriate side of the river. The wealth of graphic forms for names allows the reader to distinguish between object types (E. Imhof 1975). Labels on maps are also treated as the fourth component of map content, alongside point, line and area symbols (D.J. Fairbairn 1993).

This graphic variety of font means that it can be treated as a cartographic symbol which is important in receiving and understanding the content of a map. The quality of a map, as assessed from the graphic perspective, is largely dependent on the form of the geographical names (A.H. Robinson et al. 1995). Names on maps should help in recognising the distribution of objects, determining the range of areas and distinguishing objects.

2.1. Labels on typhlomaps

Labels on typhlomaps are also very important, although the cartographic principles described above are drastically limited.

Typhlomaps use labels in the Braille alphabet. The international Braille alphabet consists of

Dimensions (mm)	Marburg			US	Meteo
	Big	Medium	Small		
a	2.7	2.5	2.3	2.3	2.3
Z	6.6	6.4	6.2	6.4	7.5
D	1.6	1.5	1.4	1.4	1.2/1.6
H	0.5–0.8				

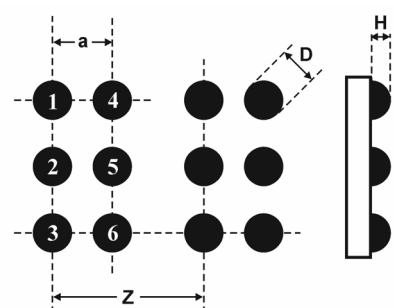


Fig. 1. The basic dimensional values of Braille characters (after L. Buczyński 2003, p. 163): a – distance between the Braille dots in the mark, Z – the distance between letters, D – diameter of the projection of the Braille dot, H – height of the Braille dot

the original 25 letters and a symbol signifying the letter 'w', as well as punctuation marks and auxiliary symbols all of which, apart from certain differences between varieties of the Braille system for particular languages, are broadly international. The basic set has none of the diacritic symbols which characterise certain languages. The linear dimensions of Braille are slightly different in individual regions of the world (fig. 1) – Europe uses the properties of Marburg Medium. The parameters of this system are adapted for tactile perception, which does not allow them to be freely modified in use.

Therefore, in the elaboration of a typhlomap:

• there is not an unlimited number of fonts and typefaces,

• differences in font size or colour cannot be used to ascribe a particular quantitative or qualitative value to an object,

• there is not a great variety of ways to transcribe or lay out names (fig. 4).

Meanwhile:

• on maps for the blind, i.e. only to be read by touch, there is only one font of strictly determined parameters, most commonly laid out horizontally; the exception is labels on town maps, where names or 'abbreviations' are placed along streets and transport lines,

• on maps for the visually impaired there are several fonts in at least two or three sizes, and selected colours, but contrasted with the background on which the labels are placed (see: 2.2. Labels for the visually impaired).

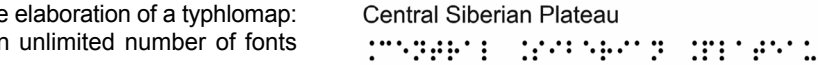
Experience gained over the past ten years or more (M. Olczyk 2014) in the development of tactile maps and their use by the blind and visually impaired, together with a knowledge of the principles of typhlography have made possible the development of "standards for the creation and adaptation of maps and atlases for blind students" (*Standardy tworzenia…* 2012). The principles relating to map labels and methods of describing objects are worthy of attention. On this matter rather a lot of solutions have been found to facilitate the reception of information in typhlomaps. Using an increased font size which has appropriate contrast for visually impaired users, together with intuitive Braille 'abbreviations' with 'keys' for the blind user, a legible map can be obtained with acceptably rich content.

In the case of coloured tactile maps, we should speak primarily of their usefulness and tactile and visual readability for the visually impaired. For this reason it is necessary to evaluate the graphic solutions used, including the means of describing objects.

2.1.1. Braille labels – the system of 'abbreviations' and 'keys'

One difficulty with the placement of labels on typhlomaps is the expansiveness of Braille writing. Solutions are sought to allow the effective and legible description of objects with long names which in Braille consume a lot of space, such as:

Central Siberian Plateau



Looking for optimal solutions which take into account all the unchangeable writing parameters and certain 'inconveniences' and limitations resulting from the nature of Braille writing, and taking into account the perceptual capabilities of the user, practical solutions were worked out and tested.

But first of all, let us cover terminology, which is very important here. Two terms will be used which are fundamental to the entire system being proposed for describing objects on typhlomaps: These are:

• Braille 'abbreviation' – the simplification of proper names which require shortening due to the expanding of the Braille alphabet. For use in tactile maps, these have been referred to as typhlocartographic Braille 'abbreviations',

• 'key' – a Braille symbol or Braille letter placed before a geographic object's abbreviated proper name to indicate the category of the object, e.g. lakes, mountains, regions.

The principles for tactile map labels provided by Polly Edman (1992) contain provisions relating to the need to use one- and two-letter 'abbreviations' together with their explanations, but these were probably formulated from simple studies involving a small number of names, where for cartographers combinations of Braille letters are enough to match individual and memorable 'abbreviations' to proper names.

In Polish cartography, a system of 'abbreviations' and 'keys' was first used in the years 1986–2003 in the development of the series of 34 maps. In this collection one- and two-letter 'abbreviations' were used preceded by 'keys' distinguishing the category of the object being described in the maps. In a further work – specifically, the *Atlas geograficzny Europy* (Geo-

graphical atlas of Europe, 2006) – it transpired that single-letter 'abbreviations' do not allow for even a fraction of the objects of typhlomaps, and it was necessary to adopt two-letter 'abbreviations'. From that moment on, two-letter the number of letters in the alphabet. 'Abbreviations' are made intuitively, looking for associations so that the sound of the abbreviation might best relate to the name of a given object. These are usually:

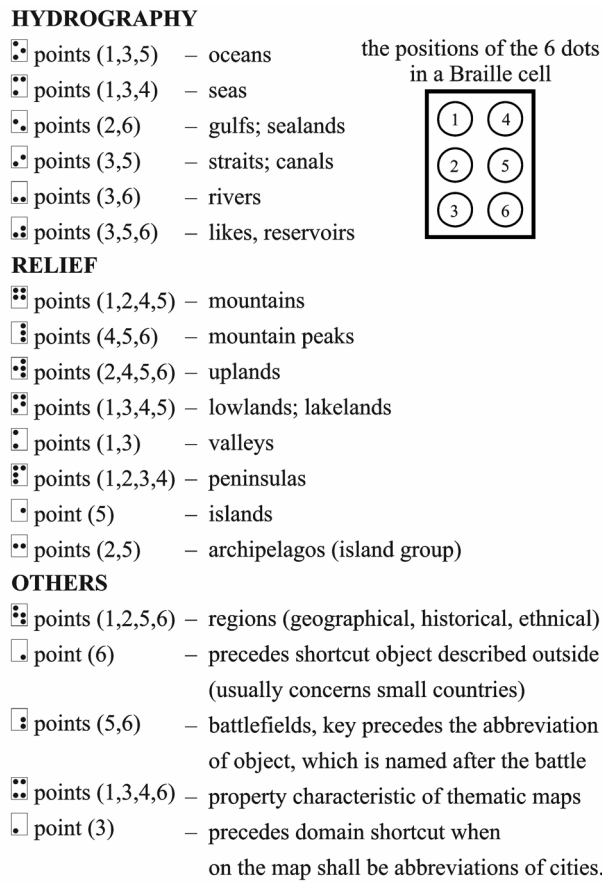


Fig. 2. List of 'keys' used in front of abbreviated proper names (the specific points of six-point Braille are given in parentheses) (source: Standards for developing and adapting maps and atlases for blind pupils, 2012 and www.tyflomapy.pl)

'abbreviations' prefixed with 'keys' have been used for selected geographic objects.

2.1.2. Braille 'abbreviations' in typhlocartography

The selection of 'abbreviations' for the names of individual content items on a map is a compromise between choosing the abbreviation most easily relatable to the object name and

• initial letters of the whole name: **al** – **Al**sace; **ey** – Lake **Ey**re; **ac** – **Ac**oncagua,

• initial letters of syllables in the name: **sd** – **S**ar**d**inia; **sb** – **Sib**eria; **mv** – **M**onte**v**ideo,

• initial letters of individual parts of a compound name: nz – New Zealand; **mb** – **M**ont **B**lanc; **cb** – **C**osta **B**rava.

One interesting issue is that of typhlocartographic 'abbreviations' which were created through

Table 1. A practical example of the use of 'keys' for objects of a shared abbreviation (source: author's own work)

Geographic names	Features	Keys	Abbreviations
Dnipropetrovsk	town	–	dn
Dnieper	river	points (3,6)	dn
Dnieper Lowland	lowland	points (1,3,4,5)	dn
Dnieper Upland	upland	points (2,4,5,6)	dn

the use of existing and widely-available, easily-recognisable abbreviations. This situation occurs in the case of 'abbreviations' of country names, where the international set of codes for countries and dependent territories was adopted in the form of the universally implemented internet domains[4], such as **pl** – Poland, **uk** – United Kingdom of Great Britain and Northern Ireland, **us** – United States of America (the domain ascribed to the USA, despite rarely being used). This solution was used in the *Atlas geograficzny Europy* (2006) and is used there to this day. Identical recommendations on country descriptors have been co-developed by two organisations – the Braille Authority of North America (BANA) and the Canadian Braille Authority (CBA) – expanding the set of 'abbreviations' with an index of 'abbreviations' for individual American states and Canadian provinces (BANA 2012).

In the Polish publication describing the editorial standards for maps and atlases for blind users (*Standardy tworzenia…* 2012) all map 'abbreviations' employed to date are gathered and arranged by their specific publications up to 2010[5]. It is important to note that over several years authors used earlier listed 'abbreviations' for the same geographic objects in successive publications. Consequently, the use of the same 'abbreviations' has given them a lot of currency, and undoubtedly speeds the visually impaired reader's access to information repeated on multiple maps and in successive publications. This is a direction in which activities should be aimed, to bring order to the issue of 'abbreviations' on tactile maps.

2.1.3. Braille 'keys'

A 'key' is a Braille symbol or letter placed before the abbreviated proper name of a geographic object (fig. 2). The list of 'keys' presented here was developed to meet the needs of Polish typhlocartography, but a similar set for other languages could successfully be developed. The essence of this system is that it makes it possible to use the same Braille abbreviation for different objects whose proper names belong to a single family names, by assigning them to their different category of geographic object. The 'key' makes them identifiable, while the shared Braille abbreviation facilitates the association and linking of objects with each other (tab. 1 and fig. 3).

In the case of a family of names associated with the name of a given country the principle of a single, shared 'key' is, in the author's opinion, all the more helpful in simplifying the reading of 'abbreviations' and remembering their explanations, due to the universal familiarity of internet domains.

The proposed application of identical Braille 'abbreviations' for objects whose proper names belong to a single family may also be used in the preparation of street name 'abbreviations' on town maps (tab. 3). These are most commonly three-letter 'abbreviations'. This relates in particular to street names in families of names of towns, regions, countries, rivers or other objects which have already had 'abbreviations' worked out for maps of physical geography. This is one practical side of the proposed system.

In 2012 recommendations were made for, i.a. the problems in applying labels to typhlo-

[4] National codes are available at: https://www.iso.org/obp/ui/#search (access 30.10.2018).

[5] This relates to the following publications: the set of maps published in 1983 by the Head Office of Geodesy and Cartography in collaboration with the Polish Association of the Blind, and four atlases: the *Atlas geograficzny Polski* (2004), *Atlas geograficzny Europy* (2006), *Atlas Unia Europejska – poznajmy się* (2009) and *Atlas do przyrody dla osób niewidomych i słabowidzących* (2010).

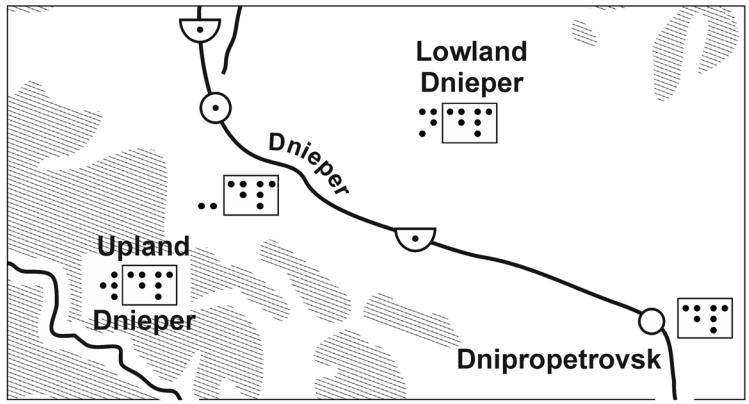


Fig. 3. *Atlas geograficzny Europy*, 2006, maps 19–20: *Ukraine – general map and land relief*. Scale 1:4,000,000 (map excerpts at original scale). The selected object names belonging to a single family of names are assigned the Braille abbreviation 'dn' (see 'abbreviation' column in table 1) and are prefixed by the appropriate 'key' (see 'Keys' column in table 1) (source: author's own work)

Table 2. A practical example of the use of 'keys' for objects of a shared abbreviation, being the country's internet domain (source: author's own work)

Geographic name	Feature	Key	Abbreviation
Germany	country	–	de (country code)
North German Plain	lowland	points (1,3,4,5)	de
Paraguay	country	–	py (country code)
Rio Paraguay	river	points (3,6)	py
New Zealand	country	–	nz (country code)
New Zealand	archipelago	points (2,5)	nz

Table 3. A practical example of the application of 'abbreviations' of geographic names to construct street name 'abbreviations' (source: author's own work)

Geographic name (feature)	Abbreviation	Name of street	Abbreviation for street
Oxford (town)	ox	Oxford Street	oxf
France (country)	fr (country code)	France Street	fra
Mazovia (historical region)	mz	Mazowiecka Street	mzo

maps (*Standardy tworzenia…* 2012), relating to the method of designing labelled pages on coloured tactile maps:

• place and country names are marked with a two-letter abbreviation without a 'key', while town names are placed in the immediate vicinity of their related text labels;

• the country name 'abbreviations' are taken from their two-letter internet domain names and, if there is space on the map for both country

and town abbreviation, the domains should be preceded by a 'key' – point 3 (fig. 2);

• the 'abbreviations' of selected geographic names are preceded by 'keys' denoting the type of object being labelled on the map (fig. 2);

• in the case of objects which have not yet been assigned a 'key', the 'x' symbol should be used as a 'key' (points 1,3,4,6) (fig. 2), or another letter as yet not assigned to such a role. (This principle rarely applies and for other objects three-letter 'abbreviations' are usually used);

• the number symbol (points 3,4,5,6) should not be used, as it may cause confusion;

• the uppercase symbol (points 4,6) should not be used as a 'key', as it may be needed to perform its primary function;

• for small numbers of names, the index of 'abbreviations' should be ordered alphabetically;

• for a significant number of names, they should first be grouped by object type and then sub-ordered alphabetically;

• in the explanations of Braille 'abbreviations', country 'abbreviations' should have the term 'country' added in order to unambiguously differentiate a city from a country of the same abbreviation.

Figure 4 shows the advantages of applying these recommendations. Map A is an excerpt of a map with labels for the visually impaired in 16-point font. Map B, next to it, has the same labels written in full in Braille, and placed so that they fit within the map border. The names overlap and cannot be placed in a legible manner. Map C exchanges full Braille labels for 'abbreviations' with 'keys' in a black rectangle. Map D, the final map, shows the end result of the editing of this map. The use of 'keys' and 'abbreviations' has allowed all labels for the visually impaired and all 'abbreviations' with 'keys' for the blind to be fitted onto the map excerpt. The map is legible.

'Keys' expand the number of 'abbreviations' available to the cartographer in producing

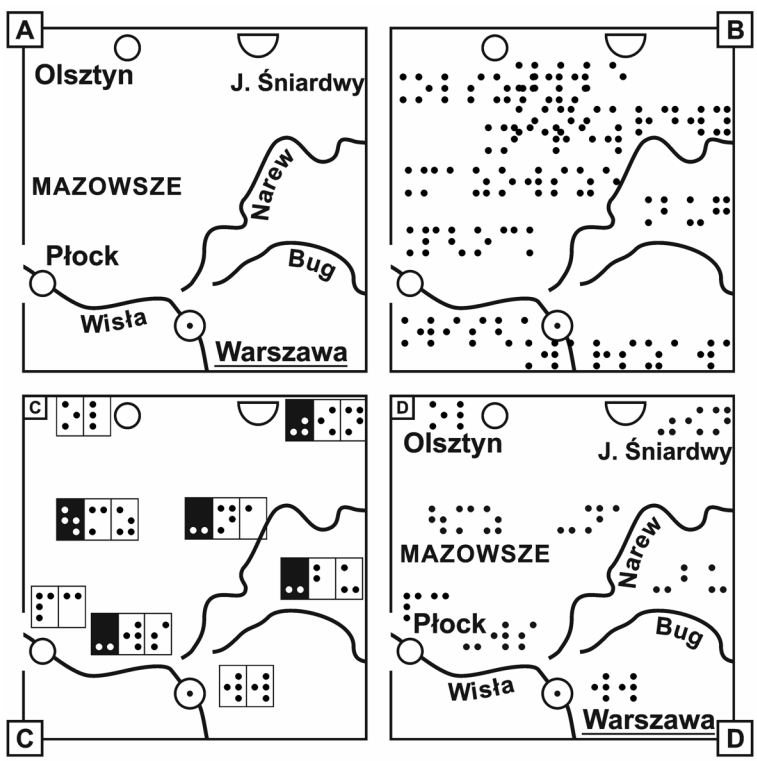


Fig. 4. *Atlas geograficzny Europy*, 2006, map 13. *Poland – general map*. Scale 1:4,000,000 (map excerpts at original scale). A – labels for the visually impaired, B – full names written in Braille, C – full Braille labels replaced by Braille 'abbreviations' prefixed by 'keys' for object type, D – map with labels for the visually impaired and the blind (source: author's own work)

tactile maps. This is important in atlas-type publications due to the significant number of names, even considering the extensive generalization of content in typhlomaps.

The main advantage of the 'key' system is the support provided to the map reader (fig. 2). The 'key' for rivers tells the reader that it relates to the line next to which the 'key' and whatever abbreviation are found, and if the abbreviation for the proper name is intuitive and well constructed the effective reader does not need to refer to either the legend or the index of abbreviation explanations, having unambiguously read from the map that the line is a river.

We do not find a similar solution with 'keys' in the literature, but there is a small number of proposals to create certain principles for the construction of Braille 'abbreviations' on maps. One example is that of publications from Spain, where the convention is that 'abbreviations' relate to the first letter of the full name. Up to three letters are usually used, depending on the available space on the map. In Brazilian cartography two-letter 'abbreviations' are used on maps of physical geography (F. García Soria and P. Ruiz Prieto 2010), and for several objects lying in close proximity to one another it is proposed to use a single abbreviation so, for example, one shared abbreviation would be used for the Dardanelles, the Sea of Marmara, and the Bosphorus. Such a grouping of names under a single abbreviation hinders the differentiation of objects, and would certainly demand an additional explanation. An abbreviation should precisely describe a specific object on the map, fulfilling the same role as a label on a traditional map.

2.1.4. Names on typhlomaps – exonyms

Sometimes objects on maps have more than one name, such as in dual-language areas. Different forms of the same name in different languages may force the cartographer to fit all required forms, which in many cases is very difficult to do due to lack of space. The author of maps is faced with the problem of the correct application of names. In the international forum, it is recommended to use the name in the official language (or languages) of a given area. This well thought out standardization allows errant forms of names to be eliminated and geographic objects to be unambiguously identified (M. Zych 2012).

On maps for the blind and visually impaired, there is not the physical space for double or triple namings. The typhlomap usually places an abbreviation for one name, with an explanation in the index of 'abbreviations' to which endonyms can also be added for a given proper name. The index of 'abbreviations' is an essential complement to any map.

It is not recommended to use geographical names with symbols beyond those of the national Braille alphabet. Names with diacritic marks from another alphabet present a certain problem of transcription into Braille, since each letter must be prefixed by an additional Braille symbol (points 2,3,4,5,6) to indicate that the next letter does not belong to the reader's alphabet). Such a letter can, unfortunately, not be recorded in a way that corresponds to its true form since it simply does not exist in that particular Braille alphabet.

Maps for general and school use are advised to use exonyms on typhlomaps, as in traditional cartography. One essential problem is therefore how to establish national sounds and spellings of names for geographic objects located beyond the borders of a given country.

2.1.5. Descriptions of tactile maps and atlases

Every coloured tactile map features a legend, an index of explanations of Braille 'abbreviations' (an index of names) and additional labels (comments on the map, or guides to the map), all of which are designed to facilitate reading and comprehension.

The legend orders the symbols used on the map and is indispensable for the correct reading and comprehension of the map content. The editing of a typhlomap aims to ensure that the tactile content corresponds to the content for the visually impaired and that the legend contains exactly the same explanations.

The index of explanations of Braille 'abbreviations' is developed to make it easy to use and to speed up searches for the meaning of a particular abbreviation (fig. 5). The adoption of two- and three-letter 'abbreviations' allows the list to be set such that the 'keys' and 'abbreviations' are in a single column. 'Abbreviations' which have an additional 'key' should be aligned

with ‘abbreviations’ without a ‘key’. A list developed in this way allows the user to quickly find the relevant explanation. Figure 5 shows the layout of Braille abbreviation explanations. Such a list is preceded by explanations of the ‘keys’.

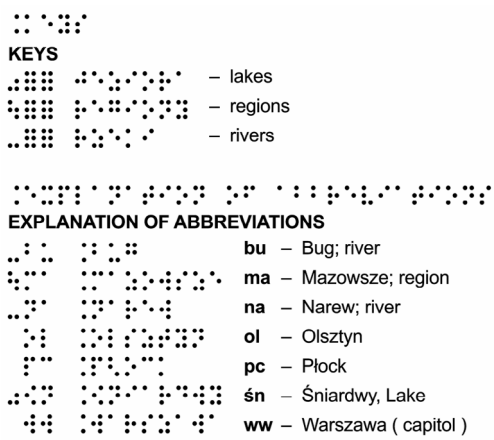


Fig. 5. Index of Braille abbreviation explanations elaborated for the map excerpt in figure 4. ‘abbreviations’ are ordered alphabetically – ‘keys’ do not influence the order of explanations (source: author’s own work)

For atlas-type publications, descriptions are generally prepared as a complement to the content of tactile maps, a substantive comment or an instruction on how to read a given map. Such ‘guides to maps’ have been prepared for several publications, including the *Atlas geograficzny Europy* (2006), the *Atlas do przyrody* (2010)[6], the *Atlas geograficzny świata* (2012) and the *Atlas historyczny Polski* (2016). It is the aim of such descriptions to tell the reader how to properly read a given typhlomap. Directing the reader along the shortest path of ‘tactile exploration’ allows the map to be grasped with both the linguistic and imaginative faculties. This requires that the descriptions be precise, and therefore necessarily long and that their authors be familiar with typhlopedagogy and typhlographics. In the case of educational publications for use in schools, it is necessary to develop methodological notes to facilitate the effective use of typhlomaps in lessons.

The linguistic description on each map is a complement without which a blind reader’s knowledge and imagination of the area presented on the map will be incomplete or erroneously understood. Language, and thus the description, play a particular compensatory role in a blind person’s process of acquisition of world knowledge, hence the requirement for additional commentary, particularly for content-rich tactile maps.

2.2. Labels for the visually impaired

For the visually impaired we use labels in a large font using a font colour which contrasts with the description’s background. The majority of labels are in black, but navy blue descriptions are also used for surface waters (lakes, rivers, seas and oceans). If, however, the name is placed on a very dark area it will need to be marked in white or yellow. The principle of high contrast is of priority, and when developing a typhlomap for a reader with severely impaired sight it is of primary importance to take this into account by remembering about the minimum size and appropriate choice of font. According to recommendations (*Standardy tworzenia…* 2012), one should:

• use a non-shaded and non-serif font of not less than 16 points; Arial font is recommended;

• names on the map should be placed horizontally, with the exception of river labels, which should follow the course of the river;

• ‘abbreviations’ should not be used, and if such need arises they should be expanded in the appended index of names.

The aforementioned principles are also employed in other cartographic schools, such as in Czech (E. Vávrová 2012).

In 2016 the *Atlas historyczny Polski* (Historical Atlas of Poland) was produced, using the contrasting combination of predominantly two colours – yellow and black[7] (fig. 6). This was the first attempt to implement such an approach to contrast in coloured tactile maps. High-contrast publications to date have been used for large-scale floor plans or public buildings, i.e. relatively simple subject matter in terms of informational load. The use of such clear and high-contrast graphics on historical maps had an impact in

[6] Sample audio file describing the Basic Map (in Polish only): http://tyflomapy.pl/TOM_I_-_POLSKA.html (access 30.10.2018)

[7] http://tyflomapy.pl/O_atlasie_8c3.html (access 30.10.2018)

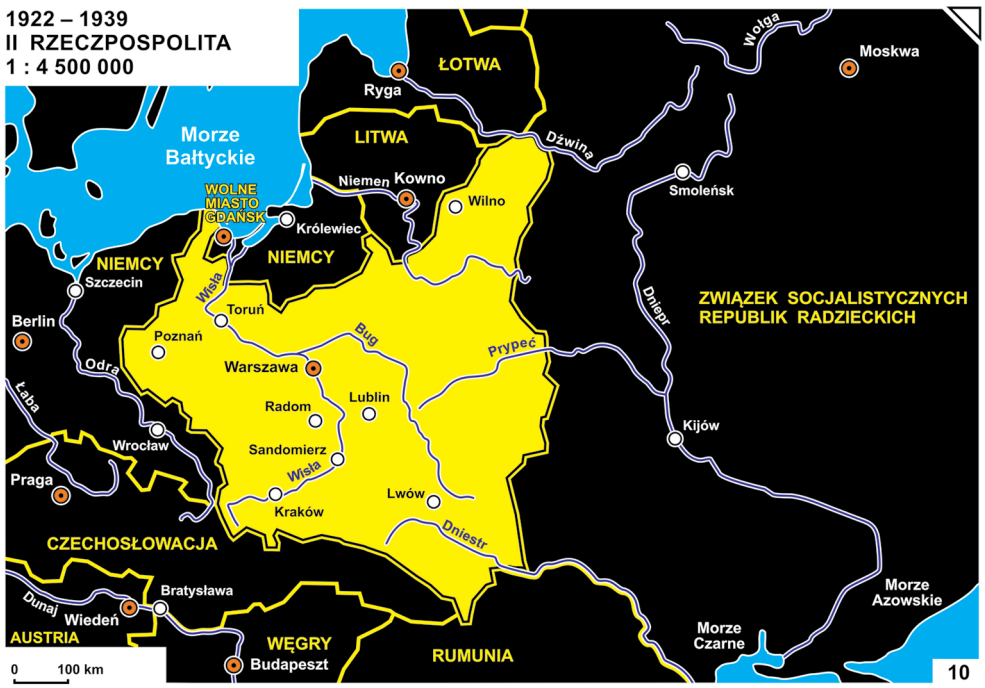


Fig. 6. *Atlas historyczny Polski dla niewidomych i słabowidzących*, 2016, map 10: 1922–1939, the 2nd Republic; map reduced by 60%, original format A3) (source: www.tyflomapy.pl)

the need to resign from the use of, for example, blue for labels on bodies of water, since blue is insufficiently legible on a black background. It similarly resulted in the need to use different colours for labels of the same category. The team of specialist working on the verification of the map concluded that the maps are more legible despite the publication's loss of a certain graphic consistency.

The presented proposal for high-contrast publications requires detailed research to analyse labels with regard not only to the choice and size of font, but above all to the background colour on which labels are placed in order to effectively communicate the information contained in the map. Is there a contrast limit which, if exceeded might have a negative influence on map legibility (too high contrast; excessively bright colours)? How can we analyse the sufficiently precise transmission of information to people with a visual impairment – what parameters should we study and is the speed of reception of information read more important than graphical legibility?

These studies should result in a fairly precise definition of the three colour-related parameters which we perceive separately, namely hue, lightness and saturation, taking the visually impaired into account. Research to date on the legibility of labels on maps has most frequently concerned itself with reception and comprehensibility for the sighted (R. Deeb et al. 2015). Expanding the research sample population to cover the visually impaired would allow their graphic preferences to also be determined.

The problem of labels on maps for the visually impaired is more difficult than the issues related to labels on tactile maps for the blind. The broad spectrum of visual defects means that while some graphic solutions are legible for one reader with impaired vision, for another with a different impairment it may still be a difficult, illegible map, whose choice of colours actually impedes use. Through consistent use of the two basic principles relating to size and contrast of font, we end up with coloured tactile maps which are usable by a relatively large group of people with residual vision, older people and the colour blind.

3. Discussion and conclusions

From the above, it can be concluded that typhlomaps can be used to understand the spatial relationships between objects on a map, but also, through the logical construction of Braille 'abbreviations' and a system of 'keys', associations can be made between items which belong to a family of shared names. Braille 'abbreviations' and 'keys' are a graphic element which identifies objects and describe them in a fairly precise manner.

The author has to date not found a comparable system for labelling typhlomaps which is as well-developed and tested in practice. The fairly detailed description of the developed principles presented herein demand that several vital questions be asked:

(1) Can the system of 'keys' fulfil the role of a legend and permit the blind and visually impaired to read a map without the need to refer to it frequently? The proposed system might also imply certain values which shape memory and certain habits or actions which are aimed at in the development of reading ability itself.

(2) Could the implementation of Braille 'abbreviations' in typhlocartography lead to the development of universal, international typhlomaps? The recognition of internet domains (the international codes for countries and dependent territories) is a contribution to this issue.

(3) Can 'keys', which are used as a standardising and organisational component for typhlomap content in atlas publications, also take on the same function in simple standalone maps with a limited number of Braille labels?

The contemporary world, filled as it is with new technology, means that reading Braille is treated as old-fashioned, or even regressive. The computer, audio file player and other more attractive forms of communicating written information have even caused a hiatus in the learning of Braille. To be fluent in reading the six-point system it needs to be learned from childhood, but in the modern world, this effort can appear unnecessary. People who lose their sight do not make the effort to learn it, assuming instead that they will learn it later if they need it, which turns out to be a serious problem. This is all leading to the disappearance of the ability to read Braille, and so to illiteracy.

Research by Jonathan Rowell and Simon Ungar (2003) on the seven aspects relating to labels and their placement on the map (Braille text, text placement, title labels, scale labels, abbreviated text, quality of print and labels date) confirm that the most serious problem is the reading of Braille labels (and familiarity with Braille, specifically) and their legible placement on the map.

Despite some doubts on the part of the author, the typhlomap is an effective tool supporting the learning of Braille, and therefore a *de facto* factor in preparing the visually impaired for daily life. It is one of the factors which can encourage a visually impaired person to learn Braille, but only when it is legible, comprehensible and interesting.

Most often we analyse publications looking for the best solutions but forgetting the perceptual capacities of the users of tactile maps. Optimum use of the information in a tactile map is possible when the blind person has knowledge of the world around him or her, knows and understands the space in which he or she is operating, and correctly understands the dependencies and relationships between the objects he or she may find along her way.

Analysis of the legibility of typhlomaps must, therefore, determine the appropriateness of the tactile publication itself, but also the abilities and capacities of the user and his/her prior education in understanding spatial concepts. The best developed technological innovations, navigational devices and spatial plans will be useless without the user having the preparation to read them.

It would be extraordinarily valuable to compare the solutions described here with the principles and experience of publishers in other countries. It would be worthwhile to discuss them in a scientific forum in order to work out the best possible universal principles to facilitate cartographers' work in producing legible tactile maps with systematised naming and labelling.

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