Generalization of school wall maps since 1840: From maps on the wall to wall maps

Generalisierung von Schulwandkarten seit 1840: Von der Karte an der Wand zur Wandkarte

Lowie Brink; Nijmegen (The Netherlands)

The hypothesis that school wall maps in The Netherlands have become plainer and clearer since the 1840s has been put forward before, but has now been confirmed quantitatively for the first time. It has been concluded from measurements of the numerical map load that school wall maps have become emptier especially during the 19th century. Furthermore, measurements of the visual angles of point and line symbols have established that the map symbols on these maps have been drawn larger and thicker until the 1930s. This particular aspect of map generalization has gradually led to a completely new map type: a wall map that can be read from a distance.

Keywords: wall map, school cartography, generalization, legibility, map load

Schon früher geäußerte Vermutungen, dass die seit ungefähr 1840 verwendeten niederländischen Schulwandkarten zunehmend einfacher und anschaulicher gestaltet wurden, können nun erstmalig quantitativ bestätigt werden. Aus Messungen der numerischen Kartenbelastung folgt, dass im Laufe des 19. Jahrhunderts Schulwandkarten immer mehr ausgeräumt wurden. Aus Messungen der visuellen Winkel von Punkt- und Linienkartenzeichen ergibt sich, dass die Kartensymbole in diesen Karten bis ungefähr 1930 immer größer und breiter gezeichnet wurden. Durch diese spezifische Form von Generalisierung entstand nach und nach ein ganz neuer Kartentyp: die auch in der Entfernung anschauliche Wandkarte.

Schlüsselwörter: Wandkarte, Schulkartographie, Generalisierung, Anschaulichkeit, Kartenbelastung

1 Visual clutter

The overloading of maps can be considered as the arch-enemy of map legibility. In a book with the sounding title *Grundsatzfragen der Kartographie* this is stated as „Überlastung des Kartenbildes ist eines der Hauptprobleme der kartographischen Gestaltung" (Bobek 1970). The map series of the Dutch *Topografische Dienst* give good examples of such overburdening. Since the 19th century they were "overfilled" to store as much information as possible. Nevertheless, they were "accepted without protest" (Commissie 1973). If necessary, users surely could for a moment take hold of a magnifying glass? But according to the well-known Swiss cartographer Imhof this should be avoided: „Es ist falsch, die Minimaldimensionen dem Kartenlesen mittelst Lupe anzupassen" (Imhof 1972). It was not the first time that he raised complaints: „In manchen Karten der letzten 150 Jahre vermag selbst ihr geübtester Benützer das Gewirre von Strichen, Signaturen, Farben und Buchstaben nicht zu entwirren" (Imhof 1967). Complaining about *visual clutter* is indeed an ever returning phenomenon. The fact that little attention was paid to the map user can explain why so long and so many over-full maps were produced. However, the wave of democratization in the sixties also seems to have left its marks in cartography: "Until 1970 cartographers did not worry much about requirements which cartographic communication has to fulfil" (Ormeling 1972). And the Czech cartographer Koláčný wrote in his famous article on a cartographic information model: "One would hardly believe how little attention has been given until recently to the theory and practice of map use" (Koláčný 1969a). The remedy against over-full maps is of course cartographic generalization. After a short introduction on this subject the generalization of school wall maps will be considered. For also from the users of certain school wall maps – pupils but also teachers – it seems to have been expected that they would apply magnifying glasses and binoculars.

2 Jedes Kartenzeichnen ist ein Generalisieren

Cartographic generalization is one of the key operations in cartography and has been put into practice for centuries. Though over-full maps were not uncommon before 1800, the growth of the topographic knowledge in the first half of the 19th century made generalization an ever-increasing necessity. Accordingly, this was the time the term generalization began to circulate (Neumann 1973; Steward 1974), even though a pioneer in this field, E. von Sydow, still used the term *Verkleinerung* in his ground-breaking article *Drei Karten-Klippen:* „Eine Klippe, welche alle Elemente der Karte berührt, und an welcher schon Viele gescheitert sind" (Sydow 1866). In 1910 A. Hettner would again try to comprehend the generalization with statements as: „Die Vereinfachung kann als Weglassung, oder die Weglassung umgekehrt als Vereinfachung aufgefaßt werden" (Hettner 1910). And somewhat later M. Eckert devoted attention to generalization in his monumental *Die Kartenwissenschaft:* „Diese ist gemeinhin das Kriterium guter und brauchbarer Karten. ... Die Ausführung unterliegt ganz und gar dem Können und Kennen des Kartenzeichners" (Eckert 1921). With the rise of cartography as a science since the fifties the attention for generalization increased. As a result the long-standing view of Eckert and others – generalization is a subjective activity and cannot be captured in objective, mathematical rules – has been called into question (Töpfer 1974). Eckert would have attended the various conferences on *automated generalization* with large eyes.

3 Schulwandkarten übertreiben mit vollem Bewusstsein

The *invention* of the school wall map in the first decades of the 19th century showed – unintendedly – revolutionary traits: „Sie hat einen Emanzipationsprozeß eingeleitet, der endlich den gemeinen Mann mit dem Weltbild erstmalig bekannt und vertraut machte" (Sperling 1986). The above mentioned E. von Sydow, a teacher at a military academy, was one of the instigators of this movement. Not only was he one of the first to comment on generalization, but also since 1838 he put his ideas into practice by publishing strongly generalized school atlasses and school wall maps. "We are indebted to E. von Sydow that at present geography can be tought by illustration in the true sense of the word" (N. N. 1853). However, despite the good example of von Sydow's school wall maps, all Dutch school wall maps from the first half of the 19th century suffer from the same defect: overfull and not clear at a distance. Between the uncritical and cheerful reviews of these maps in Dutch educational journals, the very critical assessment of P. J. Veth, a professor at the University of Leiden, makes a refreshing impression: "Therefore, the maps have to be drawn with very large dimensions, and yet only contain the most important" (Veth 1852). Probably, the overloading was a consequence of the fact that for centuries „ein Unterschied zwischen Handkarten und Wandkarten zunächst nicht gemacht wurde" (Sperling 1986). Only at the end of the 19th century clear requirements were formulated to which effective school wall maps should conform, such as by J. J. ten Have and H. Zondervan in The Netherlands (Brink et al. 2010, p. 31–33). In the map design the legibility from a distance (about 2 to 8 m) must be the central issue: „Eine relativ beschränkte Auswahl der darstellbaren Objekte in sehr deutlicher, übertreibender Hervorhebung" (Witt 1970, p. 1061). To examine to what extent these guidelines were incorporated in the Dutch school wall maps, we first have to establish methods to quantify the generalization.

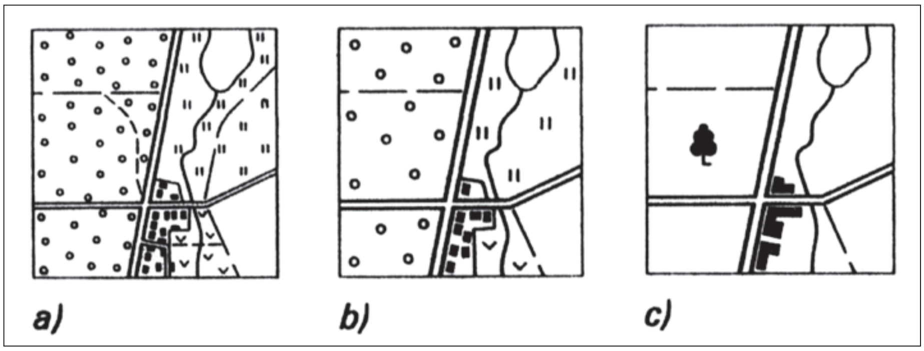

Fig. 1: Increasing degree of generalization (from a to c) with unchanging scale. The graphical map load is in all three cases almost exactly the same (8.8 %), while the numerical map load clearly decreases (reproduced from Töpfer 1974, p. 79)

4 Quantität des Karteninhaltes

Generalization is a broad conception and cannot be characterized by one quantitative measure. However, the related term legibility provides starting points, for it is determined by the number of map objects, the contrast and the shape and size of the map symbols (Bertin 1974; Ormeling 1997). Of these the number of objects (by the map load) and the size of the symbols (by the visual angle) can be easily quantified. Map load and visual angle will be elaborated below. It becomes evident that with these two concepts we can characterize the generalization to a great extent, if we look at the five procedures of graphic generalization: simplification, enlargement, displacement, merging and selection and at the four procedures of conceptual generalization: merging, selection, symbolization and enhancement (Kraak et al. 1996). Selection („die wichtigste und primäre Generalisierungsmaßnahme" (Töpfer 1974, p. 191)), simplification and merging largely determine the map load, and enlargement and enhancement determine the visual angle.

4.1 Map load

According to Koch, the Russian cartographer Suchow was the first to define the term map load in 1947 (Koch 1985). There are three variants of this still young concept: numerical, graphical and visual map load. The latter appears to be only of theoretical importance: „Ein hochkomplexer Wert, dessen Beschreibung schon rein verbal erhebliche Schwierigkeiten bereitet" (Koch 1985). The graphical map load – the area of all map elements divided by the map area – can be determined more easily (Töpfer 1974, p. 81). It is a useful criterion in map design, but as illustrated in figure 1, it does not adequately indicate the degree of generalization. Remains the numerical map load B, a simple and sketchy method, but it is unambiguously measured without difficulty (Töpfer 1974, p. 80):

$$B = (P + L + V + N) / O \quad \text{(points/cm}^2\text{)}$$

P = number of point symbols, here defined as symbols each of which can be related to a location (1 point symbol gives 1 point)

L = length of line symbols (1 cm gives 1 point)

V = area of area symbols (1 cm^2 gives 1 point)

N = number of geographic names (1 name gives 1 point)

O = map area (cm^2).

A disadvantage of this method is the addition of components of unequal value, but nevertheless it provides a crude measure of the degree of generalization. Only a relative use instead of an absolute use is meaningful when interpreting measured values of the numerical map load. Figure 2 gives an idea of the map content for different values of the numerical map load.

4.2 Visual angle

The visual angle H is defined as the (characteristic) dimension of a point symbol or the thickness of a line symbol divided by the

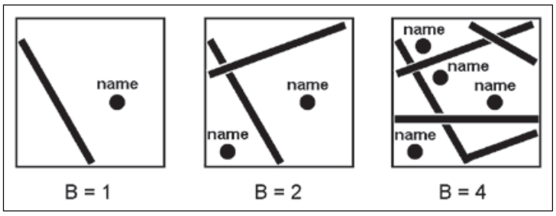

Fig. 2: Map content for three values of the numerical map load. As will be shown in fig. 3, the value B = 4 is acceptable for maps that are used at normal reading-distance but is much too high for school wall maps

reading distance, that is the distance between the eye and the map symbol (Ormeling 1997). This dimensionless group makes it possible to compare the legibility (or the formed retinal image) of symbols of relatively small maps (like atlas maps) that are used at normal reading distance (in this article 500 mm) with the legibility of symbols of wall maps that are used at much larger reading distance (in this article 5000 mm). From a minimum size of „Formen durch Linien umgrenzt“ of about 0.35 mm at normal reading distance (Arnberger 1966; Spiess et al. 2005) a rough estimate of the minimum value of the visual angle of point symbols can be derived: $H_{min} = 0.7 \times 10^{-3}$. Table 1 presents for different values of the visual angle the size of circular point symbols that give the same retinal image at reading distances of 500 and 5000 mm.

5 Mut zur weisen Beschränkung

The numerical map load of a large part of the available 19th-century Dutch school wall maps (Brink 2007) and of a selection of the 20th century Dutch school wall maps is determined according to the method described above. Area symbols are omitted in the calculation, as virtually each map displays all over the area soft political, hypsometric or soil tints, which do not much interfere with the other map elements. A characteristic part (about 600 cm^2) of the land area of each map is marked out as counting area (there is hardly any question of generalization in the empty sea area). The length of line symbols is determined with a map measurer. The counting error in P, L and N is small (at most 2 %). The main measuring fault is the choice of the counting-area, but is was established that another characteristic counting-area yields a value of the map load that differs at most 20 %. This in no way diminishes the now following results.

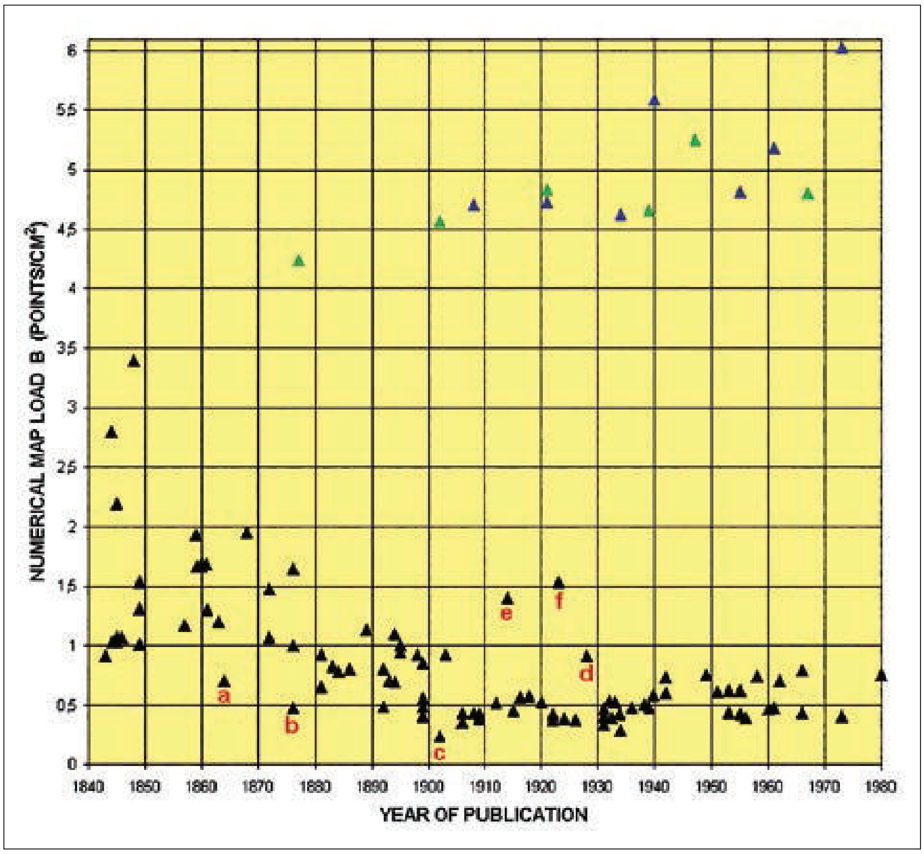

Fig. 3: Numerical map load as a function of the year of publication (black: school wall maps, green: *Bosatlas*, blue: *Bos-Zeeman* atlas)

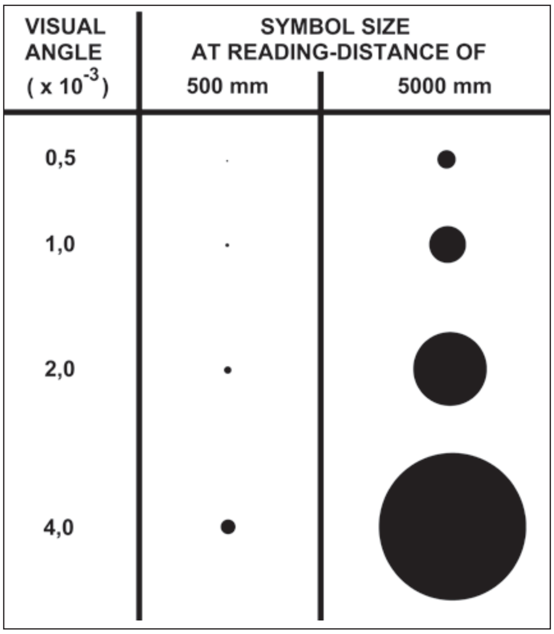

Table 1: Visual angles of circular point symbols at reading distances of 500 and 5000 mm.

Figure 3 gives the numerical map load of the investigated Dutch school wall maps as a function of the year of publication. Despite the fact that the map authors of these school wall maps form a colourful group of stubborn and autonomously working teachers, a trend can still be discerned. The first school wall maps show a relatively high map load of 1 to 3. However, in the course of the 19th century the map load decreases, and it stabilizes at about B = 0.5 since circa 1900. Accordingly, this value can be regarded as an optimal information density of school wall maps. Figure 4 presents an illustration of this development. The numerical map load of the chorographic map of The Netherlands in two well-known school atlasses – the *Bosatlas* and the smaller *Bos-Zeeman atlas* – is determined in a comparable manner, and its value is found to fluctuate round B = 5 (see fig. 3). Therefore, the information density of these two atlasses is about ten times higher than that of 20th century school wall maps. Of course, the use of school atlasses at normal reading distance allows for this higher map load. Furthermore, the maximum of 10 *Zeichen* per cm^2 (also at normal reading distance) mentioned (without evidence) by the French cartographer Bertin is not exceeded (Bertin 1974). The slightly increasing trend of both atlas maps and 20th century school wall maps can be explained by the extension of the traffic network (see for example fig. 4c and 4d).

Some points in figure 3 attract attention by their deviant position. The *Schoolkaart van het Koningrijk der Nederlanden* of C. A. C. Kruyder (1864) is the first of the investigated school wall maps that shows a map load in the region of the optimal B = 0.5 (point a). The map strikes the eye by its black colour of the land, but also by its relatively sober design. According to reviewer J. F. Jansen this map stands out favourably from all the existing school wall maps,

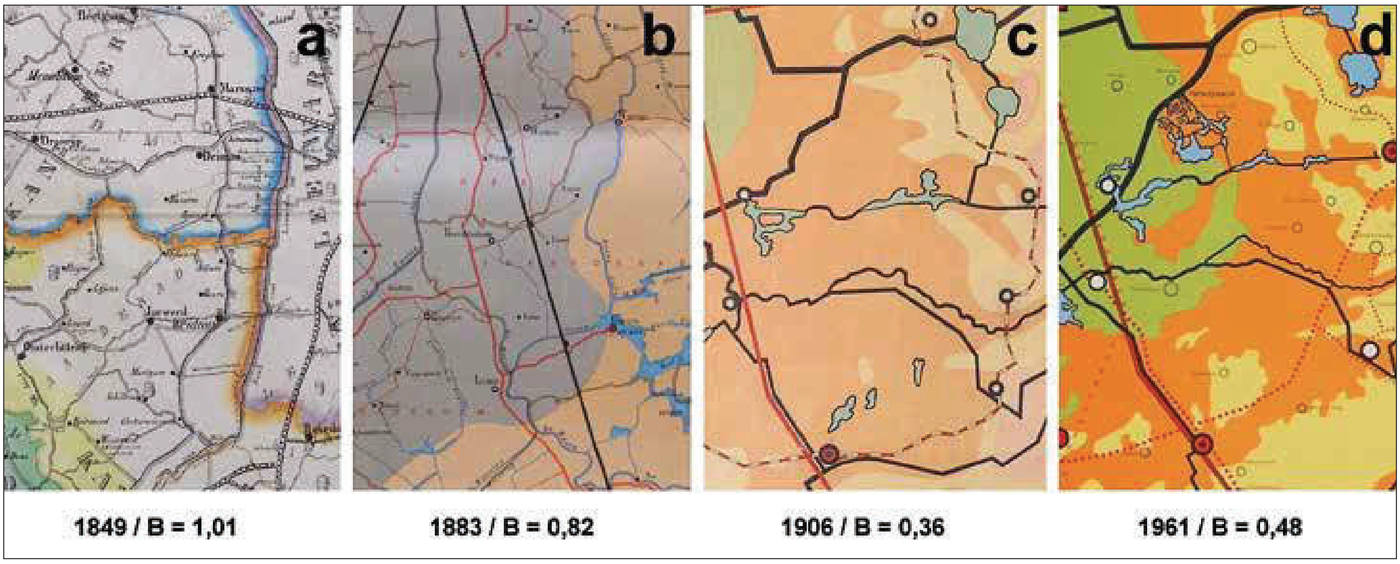

Fig. 4: Four map extracts (each circa 600 cm²) of school wall maps of Friesland (a province of The Netherlands) from the period 1849–1961 (codes FRI_OK_P, FRI_WO1A, FRI_NO1 and FRI_NO5 in Brink 2007). The numerical map load shows a declining trend (extracts a and b: scale 1:50.000, Collection Bodel Nijenhuis, Leiden University Libraries; extracts c and d: scale 1:100.000)

which "contain too much and all kinds of things" and which have in common with the "ordinary geographic maps" an "almost equal design and fullness of detail" (Jansen 1864). In 1876 Jansen himself designed a school wall map of Utrecht (see fig. 5) and had the courage to lower the map load beneath B = 0.5 (point b). In 1902 even the B = 0.25 limit was broken (point c) by primary school teacher R. Bos with a very plain school wall map of France (see fig. 6). However, in those days it yielded him a grave reprimand: "The generalization by Mr. R. Bos is getting beyond a joke" (Niermeyer 1902). In 1928 J. Schoonbeek had of course every right to design his school wall map of The Netherlands on an exceptionally small scale of 1:400.000 (point d). Nevertheless, including all the usual railway lines, canals, rivers and places in this small map did not speak of a „Mut zur weisen Beschränkung" (Stollt 1967).

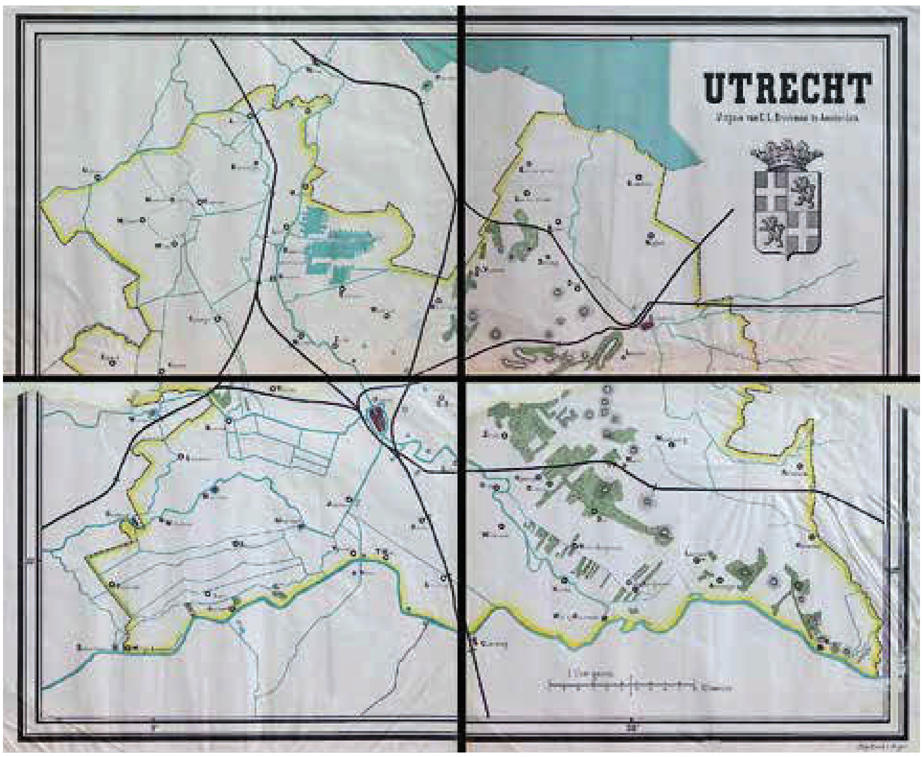

Fig. 5: School wall map of Utrecht (a province of The Netherlands) by J. F. Jansen from 1876 (point b in fig. 3) with a relatively low numerical map load (scale circa 1:56.000, Special Collections, Library University of Amsterdam)

6 Grobe Art der Darstellung

The point symbol of most frequent occurence in the Dutch school wall maps is the geometric (usually circular) place symbol. Figure 7 presents the visual angle of place symbols in the above investigated school wall maps as a function of the year of publication. The size of the largest geometric place symbol in the map is used to calculate the visual angle. The irregularly shaped symbols of the largest cities (*Ortsgrundriß*) are not considered for measurement as these can be regarded as area symbols. For verification the visual angles of the smallest geometric place symbols are also measured, but this reveals – despite a larger spreading – the same trend. Figure 7 clearly indicates

Fig. 6: School wall map of France by R. Bos from 1902 (point c in fig. 3) with a remarkably low numerical map load (scale 1:1.500.000)

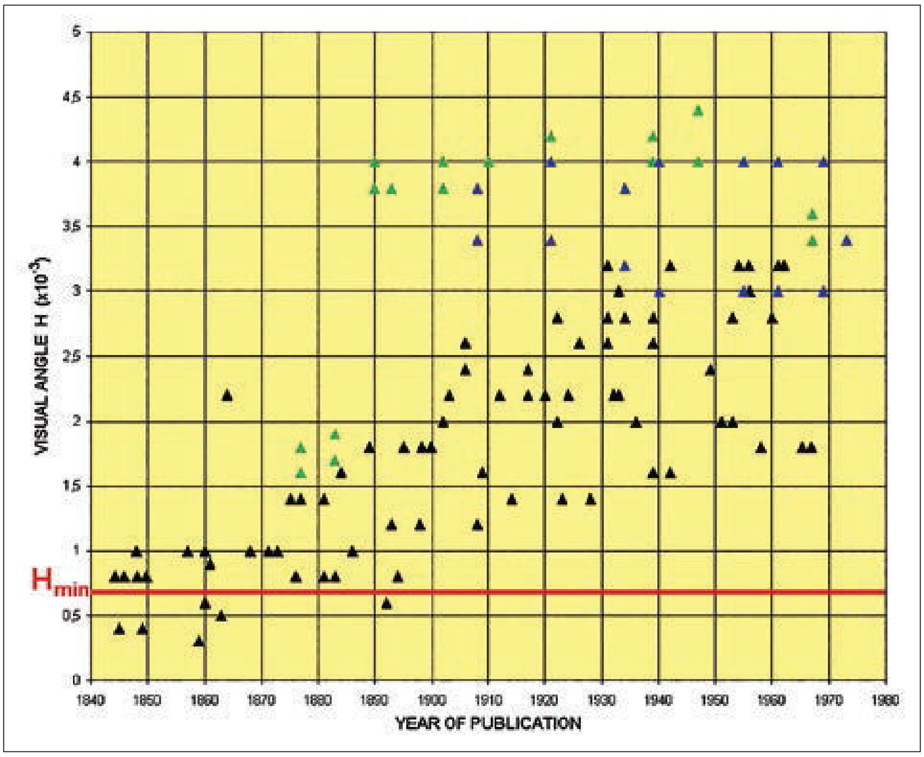

Fig. 7: Visual angle of the largest geometric place symbols as a function of the year of publication (black: school wall maps, green: *Bosatlas,* blue: *Bos-Zeeman* atlas)

the ever-increasing visual angle of place symbols: from H = 0.4 to 1.0 $x10^{-3}$ for the first maps to a maximum of H = 2 to 3 x 10^{-3} since circa 1930. Therefore, school wall maps not only became emptier, but also coarser. Figure 8 gives an example of this development. Values of the visual angle of the largest place symbols in the first school wall maps are close to H_{min}, which points out that the place symbols were drawn with much too small dimensions (see fig. 8a). Koláčný has experimentally determined that the minimum size of a circular symbol or a square symbol at a reading distance of 5000 mm and with average eyes and good light should amount to about 6 mm, which corresponds to H = 1.2 $x10^{-3}$ (Koláčný 1969b). Only circa 1900 the (largest) place symbols conform to this criterion (see fig. 8c and 8d).

The visual angles of the largest place symbols in the chorographic maps of The Netherlands and of Europe in the two school atlasses mentioned above are also indicated in figure 7. Apart from the (too) low values in the first editions of the *Bosatlas*, these visual angles are fairly constant (3 to 4.5 $x10^{-3}$). Only circa 1930 the visual angles of school wall maps come in the vicinity of those of school atlasses.

Not only point symbols, but also line symbols are depicted in school wall maps ever coarser. As a result of the large spreading in the measured visual angles of the thickest lines, this can be best summarized as follows: before 1900 visual angle mostly smaller than 0.6 $x10^{-3}$, after 1900 visual angle mostly between 0.6 and 1.2 $x10^{-3}$ (idem thinnest lines: before 1900 visual angle mostly smaller than 0.2 $x10^{-3}$, after 1900 visual angle mostly between 0.2 and 0.5 $x10^{-3}$).

In contrast with geometric point symbols there are only a few examples of pictorial symbols in school wall maps, but these nicely fit into the trend of figure 7. The pictorial symbols in two maps from 1843 and 1844 are much too small and illegible at a distance. The visual angles of depictions of elephants, bunches of grapes, sugar-beets, birds of paradise, nylon stockings, etc. in maps from 1913 and 1948 are somewhat hard to measure, but it is as clear as sunlight that these pictiorial symbols are of sufficient size.

7 Aus der Nähe eine Handkarte

Most 20th century authors of school wall maps – usually teachers – knew that their maps should be sober as they were not only the makers but also the users of these maps. However, for some of them this was prob-

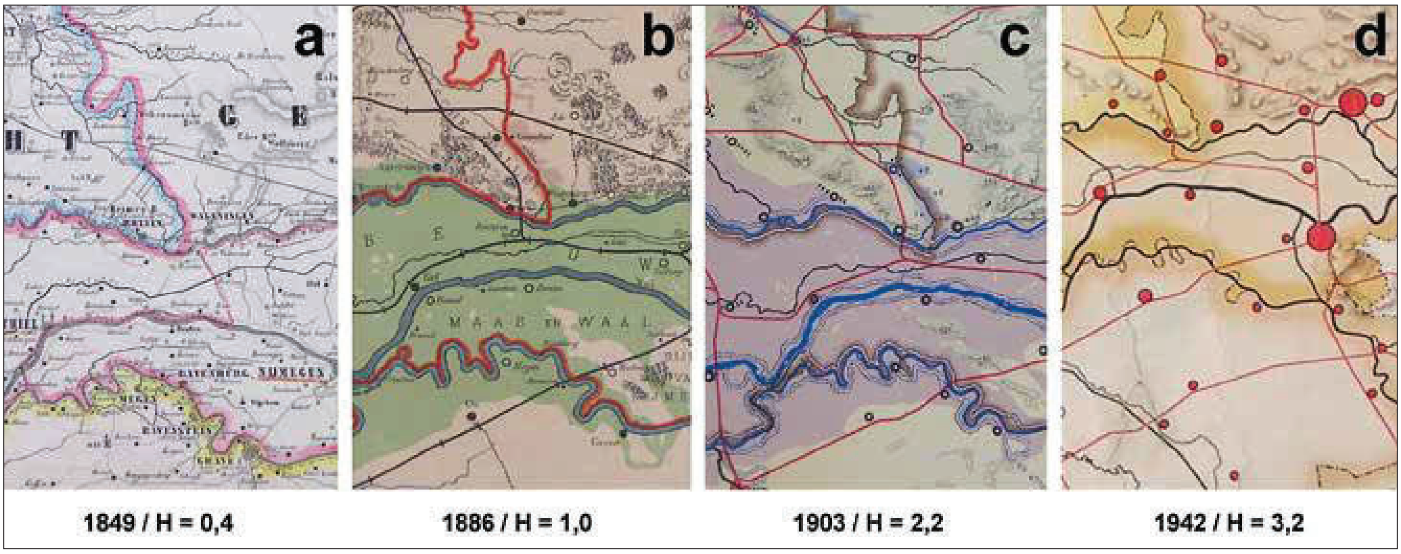

Fig. 8: Four map extracts (each circa 600 cm²) of school wall maps of The Netherlands from the period 1849–1942 (codes NED_OK1, NED_WO2S, NED_TB1E and NED_TH3P in Brink 2007). The visual angle shows an increasing trend (extracts a and b: scale circa 1:175.000, Collection Bodel Nijenhuis, Leiden University Libraries; extract c: scale 1:200.000, Special Collections, Library University of Amsterdam; extract d: scale 1:225.000)

lematic. Take for example R. Schuiling, a teacher at the Government College of Education in Deventer, who was notorious for his pursuit of completeness. Accordingly, he included many details in his school wall map of The Netherlands from 1914, which resulted in a deviant position in figure 3 (B = 1,40, point e) and a critical comment of his colleague and rival A. A. Beekman: "The author should take care not to depict all sorts of things that are unnecessary" (Beekman 1915). However, as compared to the likewise over-full 19^{th} century school wall maps, Schuiling's map shows an odd characteristic. At a distance many details (like small places, brooks, tramways, names) become illegible, while the essentials remain (like large places, rivers, railways, soil types). By making use of this „gewissermaβen automatische optische Generalisierung" (Witt 1970, p. 1063) by the eyes of the map user, Schuiling has tried to design a wall map that is legible at a distance and still offers the map user the opportunity to look up details at close quarters. Optical generalization was even more pronouncedly employed in R. Noordhoff's *Nieuwe wandkaart van Nederland* from 1909, which later on was perfected by K. Zeeman (for example the fourth edition, 1923, point f in figure 3). An extract of this map of Nijmegen and surroundings (see fig. 9 right) shows many details: small places, names, (projected) canals, brooks, tramways, altitudes, ferry-boats, etc. At a distance these details disappear and mainly larger places, large rivers, railways and the soil type colouring remain legible (see fig. 9 left). Already in 1909 this phenomenon was correctly noticed: "At a distance only the main points are observed. But when one draws nearer, one discovers that almost everything is depicted with soft tints" (N. N. 1909). It is questionable whether optical generalization

Fig. 9: *Nieuwe wandkaart van Nederland* by R. Noordhoff and K. Zeeman from 1923 (fourth edition, scale 1:200.000) and to the right a map extract of this wall map (Nijmegen and surroundings). The many details are almost invisible at large distance

of wall maps is a Dutch invention. The phenomenon also seems to have been applied in Russian wall maps for a long time (Witt 1970, p. 1063), and furthermore „die kombinierte Hand-Wandkarte" is not unknown in Germany: „Die großen zur Verfügung stehenden Flächen bieten die Möglichkeit, die Wandkarte mit zarten Zeichnungen inhaltlich so anzureichen, daß sie aus der Nähe betrachtet einer Handkarte gleich kommt" (Painke 1972).

8 Generalization of the results

The above graphs show it in black and white: Dutch school wall maps became more and more sober. Especially during the 19^{th} century the maps were increasingly less overloaded and became ever emptier, which made room for larger and clearer symbols. This trend fitted into the development of 19^{th} century geography education towards less details and more insight. The emphasis given by Ten Have and Zondervan to legibility at a distance certainly was still necessary at the end of the 19^{th} century, but the trend towards sober wall maps already made a start earlier that century. The legibility of school wall maps noticeably increased: an emptier map was the remedy against the blurredness of the first maps, and the application of larger symbols resulted in a clear contrast.

If the trends in the map load of school atlas maps and school wall maps are extrapolated in the direction of the year 1800, it seems that these two map types have a joint ancestor: the school maps from the 18^{t}h century and the beginning of the 19^{th} century, which were sometimes inserted in geographic text-books and which were to be used at normal reading-distance (Brink et al. 2010, p. 10-16). In contrast with the school atlas map, the school wall map, however, felt little affinity for this ancestor. During the 19th century it developed by the generalization described above into a map of an entirely new type – the wall map legible from a large distance – and, accordingly, freed itself from the shackles of convention of maps that are used at normal reading distance like atlas maps and office wall maps.

However, this *invention* took a large part of the 19th century to gain ground. The map authors hardly had any contact with each other, and the wheel had to be reinvented with each new school wall map. Furthermore, a map author had often not got the nerve to deviate from existing maps: „Es gehört schon einiger Mut dazu, ein so leeres, abstrahiertes Erdabbild als fertiges kartographisches Produkt anzubieten“ (Stollt 1967). Apparently, the application of very large point symbols (circa 15 mm) demanded even more courage than the design of empty maps, as only since circa 1930 authors dared to use such symbols. The appearance of these giant symbols in the Dutch school wall maps finally decided the long battle between completeness and legibility for the latter. It would be interesting to know how this battle was won in countries other than The Netherlands. Hopefully, sufficient numbers of 19th century school wall maps have survived the wear and tear of time to make such a reconstruction possible.

Literature

Arnberger, E. (1966): Handbuch der thematischen Kartographie. Wien, p. 56

Beekman, A.A. (1915): Nieuwe schoolkaarten van Nederland. In: Tijdschrift van het Kon. Nederlandsch Aardrijkskundig Genootschap XXXII, p. 678–683, quot. p. 681

Bertin, J. (1974): Graphische Semiologie: Diagramme Netze Karten. Berlin, p. 183–189

Bobek, H. (1970): Gesamtanlage und Einzelgestaltung. In: Grundsatzfragen der Kartographie, E. Arnberger (ed.), Wien, p. 62

Brink, L. E. S. (2007): Bibliografie en foto-overzicht van de Nederlandse schoolwandkaarten (1801–1975). Nijmegen

Brink, L. E. S. and L. M. A. Holl (2010): De wereld aan de wand: de geschiedenis van de Nederlandse schoolwandkaarten. Zwolle

Commissie heruitgave Topographische en Militaire Kaart (1973): Heruitgave van de eerste editie van de ‘Topographische en Militaire Kaart van het Koningrijk der Nederlanden’. In: Geografisch Tijdschrift – Nieuwe Reeks VII, p. 383–388, quot. p. 384

Eckert, M. (1921): Die Kartenwissenschaft: Forschungen und Grundlagen zu einer Kartographie als Wissenschaft. Berlin, vol. I, p. 332 and 339

Hettner, A. (1910): Die Eigenschaften und Methoden der kartographischen Darstellung. In: Internationales Jahrbuch für Kartographie II (1962), p. 13–35, reprint of article from 1910, quot. p. 18

Imhof, E. (1967): Die Kunst in der Kartographie. In: Internationales Jahrbuch für Kartographie VII, p. 21–32, quot. p. 26

Imhof, E. (1972): Thematische Kartographie. Berlin, p. 220

Jansen, J. F. (1864): Schoolkaart van het Koningrijk der Nederlanden. In: Nieuwe Bijdragen ter Bevordering van het Onderwijs en de Opvoeding etc., p. 654–656, quot. p. 655

Koch, W. G. (1985): Zur Erforschung von Gesetzmäßigkeiten der visuellen Kartenbelastung. In: Fortschritte in der geographischen Kartographie, H. Richter et al. (eds), Gotha, p. 330

Koláčný, A. (1969a): Cartographic information: a fundamental concept and term in modern cartography. In: Cartographic Journal 6, p. 47–49, quot. p. 47

Koláčný, A. (1969b): Utilitarian cartography: the road toward the optimal effect of cartographic information. Prague, ICA Working Group paper, p. 20–21

Kraak, M. J. and F. J. Ormeling (1996): Cartography: Visualization of spatial data. Harlow, p. 92–96

Neumann, J. (1973): Begriffsgeschichte und Definition des Begriffs ‚kartographische Generalisierung‘. In: Internationales Jahrbuch für Kartographie XIII, p. 59–67

Niermeyer, J. F. (1902): De tentoonstellingen in Antwerpen en in Amsterdam. In: Tijdschrift van het Kon. Nederlandsch Aardrijkskundig Genootschap XIX, p. 856–869, quot. p. 865

N. N. (1853): Over kaarten voor de natuurkundige geographie etc. In: Nieuwe Bijdragen ter Bevordering van het Onderwijs en de Opvoeding etc., p. 23–29, quot. p. 24

N. N. (1909): Nieuwe wandkaart van Nederland. In: Het Katholieke Schoolblad 2, p. 182

Ormeling, F. J. (1972): Verslag studiedagen kartografische kommunikatie. [Groningen], p. 2

Ormeling, F. J. (1997): Kartografische grammatica: de grafische variabelen. In: Kartografisch Tijdschrift XXIII, no. 4, kernkatern 8, p. 32

Painke, W. (1972): Haacks Wandatlanten gestern und heute. In: Kartographische Nachrichten 22, p. 180–183, quot. p. 182

Sperling, W. (1986): Wandkarte, Schulwandkarte. In: Handbuch Medien im Geographie-Unterricht. Düsseldorf, p. 149–150

Spiess, E., U. Baumgartner, S. Arn and C. Vez (2005): Topographic maps: map graphics and generalization. Swiss Society of Cartography, Cartographic Publication Series no. 17, p. 26

Steward, H. J. (1974): Cartographic generalization: Some concepts and explanation. In: Supplement no. 1 to Canadian Cartographer 11 (1974), monograph no. 10

Stollt, O. (1967): Der Fortlauf der Generalisierung durch die Maßstabsfolge. In: Kartographische Generalisierung: Ergebnisse des 6. Arbeitskurses Niederdollendorf etc. Mannheim, Textband, p. 40

Sydow, E. von (1866): Drei Karten-Klippen. In: Geographisches Jahrbuch I, p. 348–361, quot. p. 358

Töpfer, F. (1974): Kartographische Generalisierung. Gotha

Veth, P. J. (1852): Populaire aardrijkskunde in ons vaderland. In: De Gids 16, II, p. 529–561, quot. p. 538

Witt, W. (1970): Thematische Kartographie. Hannover, 2nd print

About the author

Dr. ir. Lowie Brink (info@wereldaandewand.nl) gained his master’s degree in chemical engineering at Delft University of Technology and his Ph.D. at Wageningen University and Research Centre. He is the owner of the antiquarian bookshop ‘De Wereld aan de Wand’ (www.wereldaandewand.nl), which specializes in wall maps. He published several articles, two books and a bibliography on the subject of Dutch school wall maps.

About this article

A Dutch version of this article has appeared in Geo-Info 8 (2011), no. 7/8, p. 24–30.

Manuskript eingereicht am: 17.4.2016
Manuskript angenommen am: 18.5.2016