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Published online: 16 Mar 2023.

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Getting to the Point? Rethinking Arrows on Maps

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Introduction

> Maps help to form public opinion and build public morale. When the war is over, they will contribute to shaping the thought and action of those responsible for the reconstruction of a shattered world. Hence it is important in these times that the nature of the information they set forth should be well understood (Wright, 1942: 527).

Maps form an essential part of the language used to communicate conflict. They are used to plan military operations and to indicate their consequences to a wider audience by providing the visual basis for articulating the movement of troops, displaced populations and shifting territories between competing powers. Consequently, mapmakers draw from a well-used toolbox of symbols and techniques to describe the dynamic nature of war in familiar ways. For those maps designed for public consumption, which is our focus here, these methods often include broad, swooping arrows for representing movements of troops and displaced people, starburst or explosion symbols for battles and the use of strong colours for changes in territory.

In many respects, mapmakers working in the news media conformed to these established cartographic norms when they first responded to Russia's invasion of Ukraine on 24th February 2022. However, unlike previous conflicts that have attracted global attention, their maps were subject to wider critique – particularly on social media – which brought into sharp focus the way that maps can communicate the consequences of war and prompted some cartographic innovation.

The critique coalesced around two themes: first, how territory was being represented in terms of Russian gains (and therefore Ukrainian losses) during the first weeks of the conflict (see Fafinski, 2022); and second, how the huge exodus of Ukrainians from their country should be captured cartographically (see Cheshire, 2022). The latter, especially, prompted questions about the suitability of using arrows to indicate the flow of Ukrainian refugees to surrounding countries when arrows were being used simultaneously to indicate invading Russian troops.

In this short paper, we aim to provide a critical examination of whether the arrow is fit for purpose in communicating the displacement of people as a direct result of conflict. Since arrows have become the go-to cartographic symbol for portraying movement, particularly as a result of war and other geopolitical events, we explore their origins and evolution on maps before discussing how arrows and their alternatives have been used in news media coverage of the war in Ukraine. We contend that critique and innovation is necessary for the development and use of more effective, and ultimately more appropriate, cartographic symbology.

Why Now?

War provides a great stimulus to cartography (Robinson, 1947). Maps serve on the front line as weapons against fear of the unknown, meeting the demand for accurate information for a variety of users and at a range of scales (Kent, 2020). As such, war provides a catalyst for cartographic innovation, through both the technology used in making maps and the symbols used on them (see Hershey, 2012).

With that in mind, the wealth of discussion and responses on social media that inspired this paper were – in part – initiated by a tweet (Figure 1). This was sent with the confidence that producers of maps and graphics within the news media have both the commitment and capacity to improve and innovate, thanks to the particular context (set out in the following paragraph) in which the public mapping of events in Ukraine occurred.

James Cheshire
@spatialanalysis   …

It's time to innovate the ways we show people fleeing war.
8 arrows for 874,026 human beings is not good enough.
It's also the same visual language we use for the invaders. 1/3

Which countries are Ukrainians fleeing to?

5:57 PM · Mar 2, 2022 · Twitter Web App

ıl View Tweet analytics

78 Retweets   28 Quote Tweets   507 Likes

Figure 1. Tweet sent on 2nd March 2022 questioning the use of arrows to depict the plight of refugees from Ukraine, shortly after the Russian invasion on 24th February.

The 2022 invasion followed two years' coverage of a global pandemic, which placed data visualization at the centre of the news cycle, especially on social media (Hamaguchi *et al.*, 2020). This had two important impacts. The first is that news organizations expanded their data journalism teams, who are highly skilled and increasingly reflective about their outputs. These teams have been pioneers in many of the ways that data are presented, not just during the pandemic but also during significant recent events such as natural disasters and political elections. Second, audiences have become more accustomed to regarding maps and graphics as core components to a news story and have come to expect outlets to be innovative but also sensitive and responsible in their reporting. This context is, therefore, what sets the cartographic coverage of the invasion of Ukraine apart from that of previous conflicts and crises – most notably the plight of Syrian refugees or the Russian invasion of Crimea in 2014 – when established cartographic approaches were applied in the relative absence of a capacity to innovate and when they attracted less critique.

However, before we turn to their recent use for mapping refugees leaving Ukraine, it is important to examine the function and design of arrows on maps more generally. An exhaustive genealogy of this familiar symbol lies far beyond the scope of this paper, so we offer an overview of its origins and evolution as a cartographic device for conveying movement and explore the emergence of its negative connotations. This provides the basis for showing how a critical look at the suitability of arrow symbols – catalysed by the initial provocation on Twitter – led to innovative attempts to unite their denotative and connotative functions in a more effective and positive way.

The Function and Design of Cartographic Arrows

For centuries, arrows have been used on maps to indicate the movement and direction of dynamic (and often linear) phenomena. As with all cartographic symbols, arrows have both denotative and connotative functions: their graphical characteristics can indicate movement (arrowhead), magnitude (thickness), extent (length) and direction (path orientation) and suggest ideas and emotions (e.g., danger and vulnerability through size, location and colour) that draw on associations that vary culturally and personally.

Maps communicate their messages both denotatively and connotatively (MacEachren, 1995). In many cases, a map symbol's denotative and connotative functions work in unison to communicate effectively, whereas for others, they come into conflict. As we set out below, however, it is difficult to separate the use of arrows for denoting the magnitude of movements of refugees (or any victims of circumstance) from the negative connotations that have been derived from their status and use as the go-to solution for showing territorial invasion and expansion.
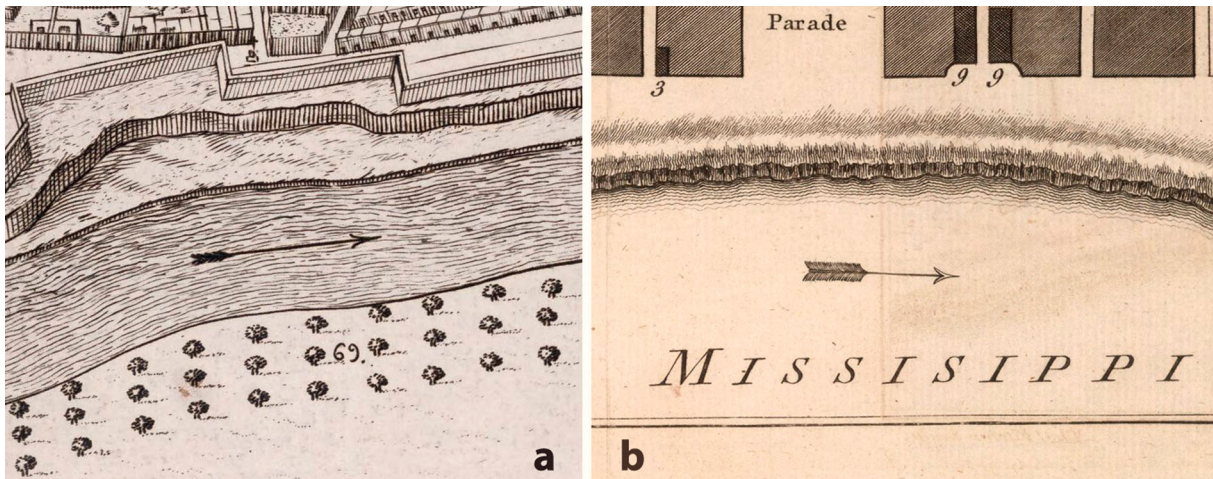
Denotation

Aside from their use for orientation in compass roses and in celestial mapping (where they depict the arrow of Sagittarius), amongst the first uses of the arrow as an independent cartographic symbol was to indicate the flow direction of rivers. Thin and elegant, with small arrowheads and fletched tails, examples from the eighteenth century, such as those used in European colonial mapping of the Americas (Figure 2), show how their appearance was intended to closely mimic that of an archer's arrow.

With the growth of statistical mapping during the nineteenth century, cartographers began to use arrows for denoting the direction of national and international flows of people and goods. Early examples include the

Figure 2. (a) Arrow indicating the flow direction of the river Rímac, from an engraved map of Lima, Peru, appearing in *Relacion historica del viage hecho de orden de S. Mag. A la America Meridional* by Antonio de Ulloa and Jorge Juan, published in Madrid by Antonio Marin, 1748. Reproduced courtesy of David Rumsey Historical Map Collection (list no. 14378.000). **(b)** Arrow indicating the direction of the river Mississippi, from a map of New Orleans, Louisiana, engraved by Thomas Kitchin and appearing in *The present state of the European settlements on the Missisippi; with a geographical description of that river* by Philip Pittman, published in London by J. Nourse in 1770. Reproduced courtesy of David Rumsey Historical Map Collection (list no. 14327.013).

use of fletched arrows on sinuous lines showing the geographical dispersal of various tribes in Europe, distinguished by hand-colouring (Figure 3) and printed arrows without fletches showing intra-national migration (Figure 4). Colour printing, especially chromolithography, expanded the possibilities of data

Figure 3. Extract from 'Map No.VI. Migrations, Settlements &c. Of Barbarous Tribes' by Emma Willard, appearing in *Ancient Atlas to Accompany the Universal Geography by William C. Woodbridge and Emma Willard*, published in Hartford, Connecticut by Belknap and Hamersley in 1827. Reproduced courtesy of David Rumsey Historical Map Collection (list no. 3023.007).
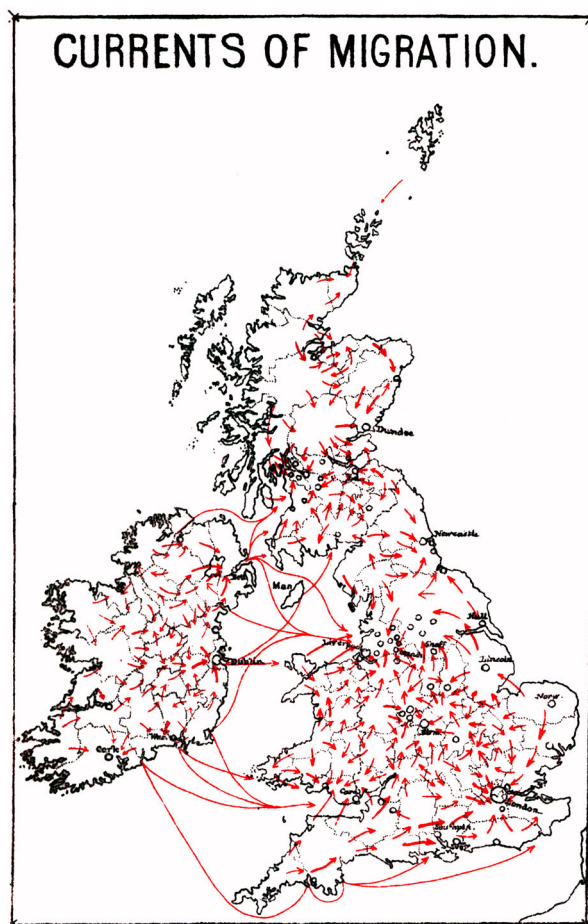
Figure 4. Ernst Ravenstein's 'Currents of Migration' (1885). It was one of a number of maps Ravenstein produced to show the movements of people around the British Isles based on his analysis of the 1871 and 1881 censuses.

classification and visualization through greater consistency in colour and form, which became necessary for increasing the legibility of linear symbology.

The function and design of arrows underwent a transformation in the twentieth century, although new methods for indicating flows of people were slow to emerge. Arrows tended to look uniformly thin with no indication of the magnitude of flow represented by each line. Greater magnitudes, for example, were suggested by drawing more arrows, as per the maps by Du Bois (1917) and Cvijić (1918) (Figures 5 and 6). These examples were created when the cartographic portrayal of ethnography was gaining significance, reaching its zenith in the re-drawing of borders for the Paris Peace Conference and Treaty of Versailles in 1919. Nevertheless, a sense of relative magnitude had already been introduced to arrowless flow lines on maps by altering their thickness. The first to introduce the technique was Henry Drury Harness, whose lines of varying width were used to indicate traffic volume and passenger numbers along railway lines in Ireland (Figure 7). The method became synonymous with maps produced by the French engineer Charles Joseph Minard, especially with his 1869 depiction of troop losses during Napoleon's ill-fated march on Moscow, and with his various trade-flow maps (Figure 8). By the end of the nineteenth century, the technique had been adopted widely, particularly for depicting the flow of various forms of transportation.
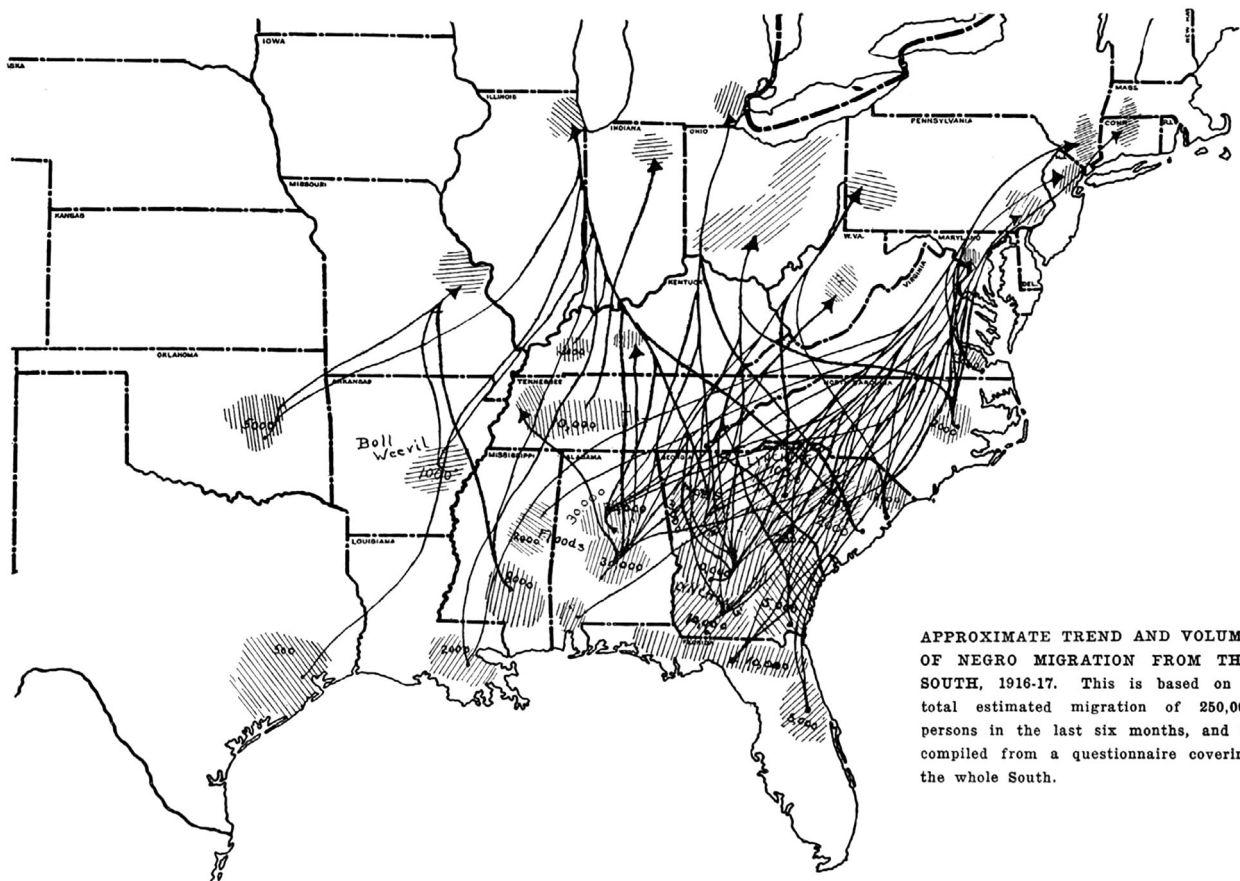
For cartographic arrows, however, there is little evidence of varying widths being in use prior to the 1930s. Although Minard-style maps of trade flows were abundant, their flow lines did not end in arrowheads and their directions were annotated by smaller arrows, either alongside or above the flow lines. The flow lines themselves also tended to be fairly straight, rather than use more dynamic, sweeping curves that are characterized by the symmetry of a single arc. The map produced by Silishchensky in 1929 (Figure 9) is an early example of arrowheads being applied to flow lines of varying thickness (thereby combining magnitude with direction), and the map also shows population density using repetitive red dots of two different sizes. Although there are clear visual similarities in style and subject matter to Minard's work, Silishchensky's map is amongst the first of its kind that we can find to include arrowheads at the end of each line.

Throughout the 1930s, cartographic arrows of varying thickness and simpler forms began to emerge more regularly. By the end of the decade, they had become sufficiently established as a cartographic device for Erwin Raisz to include them in his seminal textbook *General Cartography* (1938). Indeed, Raisz refers to arrows explicitly in their use for 'maps of the migration of men or of animals', whose movements should be 'shown by arrows, the thickness of which is proportionate of the number of migrants: the exact route of migration is not always followed' (p.265). For an example of this technique, Raisz points to C.W. Thornthwaite's (1934) maps of the 'Internal Migration in the United States', noting that 'in these maps even the general route taken is disregarded, and only the states of birth and of present residence of the migrants are connected by arrows of varying width' (Raisz, 1938: 265). However, while Thornthwaite generalizes the origins and destinations of the migrants, his map offers precision in the line thicknesses (Figure 10) and on an adjacent flow map, the arrows are annotated with the precise numbers of migrants. Thornthwaite's maps are relatively dense, but they refrain from using a bold arrowhead or a more saturated colour, opting instead for an elegant curve and partial transparency on the line to give a subtler appearance.

Although the denotative capabilities of flow lines and arrows on maps broadened through the nineteenth and early twentieth centuries, their core functions have largely remained unchanged. Their simple design has considerable scope to convey quantitative as well as qualitative information, yet their quality of expression is

APPROXIMATE TREND AND VOLUME OF NEGRO MIGRATION FROM THE SOUTH, 1916-17. This is based on a total estimated migration of 250,000 persons in the last six months, and is compiled from a questionnaire covering the whole South.

Figure 5. Map accompanying the article 'The Migration of Negroes' by Du Bois (1917: 64). To produce this map, Du Bois compiled data from a range of surveys to show the northwards migration of African Americans. It was accompanied by testimonies from those making the move who shared their motivations for doing so.

not limited to the communication of mappable data. Their success as an effective cartographic symbol is also derived from their power in suggesting the potential consequences of movement and change.

Connotation

Whilst the denotative function of a cartographic symbol indicates the particular characteristics (such as category, magnitude, distance and direction) of a phenomenon, symbols on maps also have a connotative function. This refers to what the symbol suggests by association, which varies by culture, circumstance of use, and individual. These subjective associations can be highly emotive, relying on personal memory, shared experience and imagination to work, and can be triggered by the use of certain colours, fonts and graphical hierarchy (visual layering) (MacEachren, 1995; Muehlenhaus, 2013).

This connotative function also evolves, as connotations themselves carry relevance that varies with time and place. Generally, arrows are used for conveying movement and direction, but they also introduce a dynamic element to an otherwise static map of an orderly world, which implies change and disruption to the status quo. Their real-world referent is an ancient missile weapon, which the first arrows on maps resembled. Indeed, it is difficult to separate a sense of threat from even the thin and fletched designs of the first arrows on maps, whose precise rendering suggests an ability to pierce and inflict harm.

Military cartographers have taken advantage of the connotative power of the arrow to communicate threats and vulnerabilities, both for attackers and defenders. Fletched arrow symbols have been used in military mapping from at least the mid-nineteenth century. For example, Franz Ritter von Hauslab chose this type of symbol to suggest possible invasion axes along which Vienna might fall under attack (Figure 11). Although his arrows are virtually identical in form to those indicating river flows discussed above, the notable addition of their being coloured red amplifies the sense of threat. This association draws on an underlying schema where red is used to connote a sense of danger and is likely to have been derived from the colour's association with heat and intensity (Tham *et al.*, 2020). Hence, when combined with their colouring in red, arrows can have an especially persuasive effect.
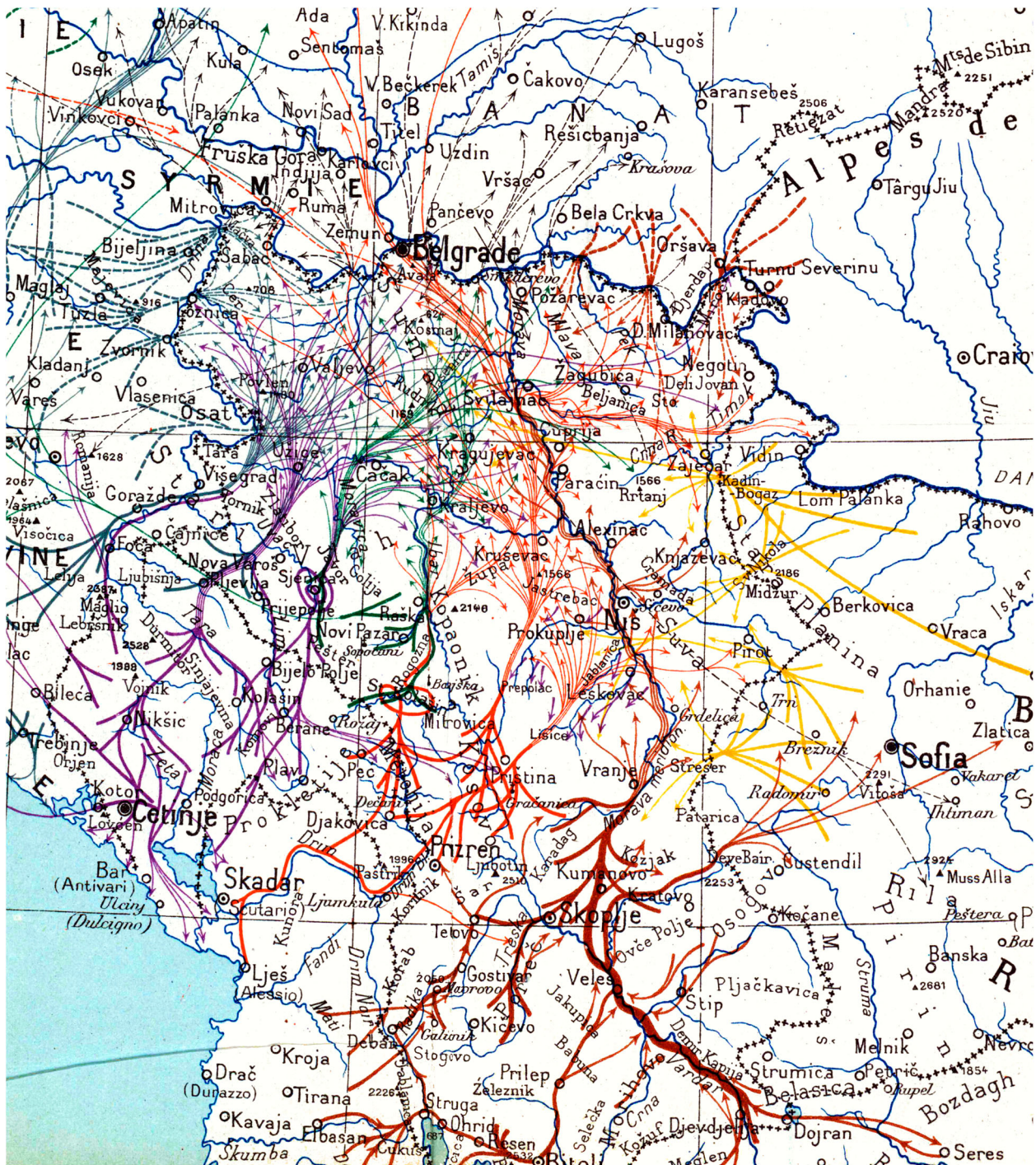
Figure 6. Extract of a map showing 'metanastastic movements in the settlement of Serbian countries from the fifteenth century to the present', appearing in *La Péninsule Balkanique: Géographie Humaine* (Cvijić, 1918).
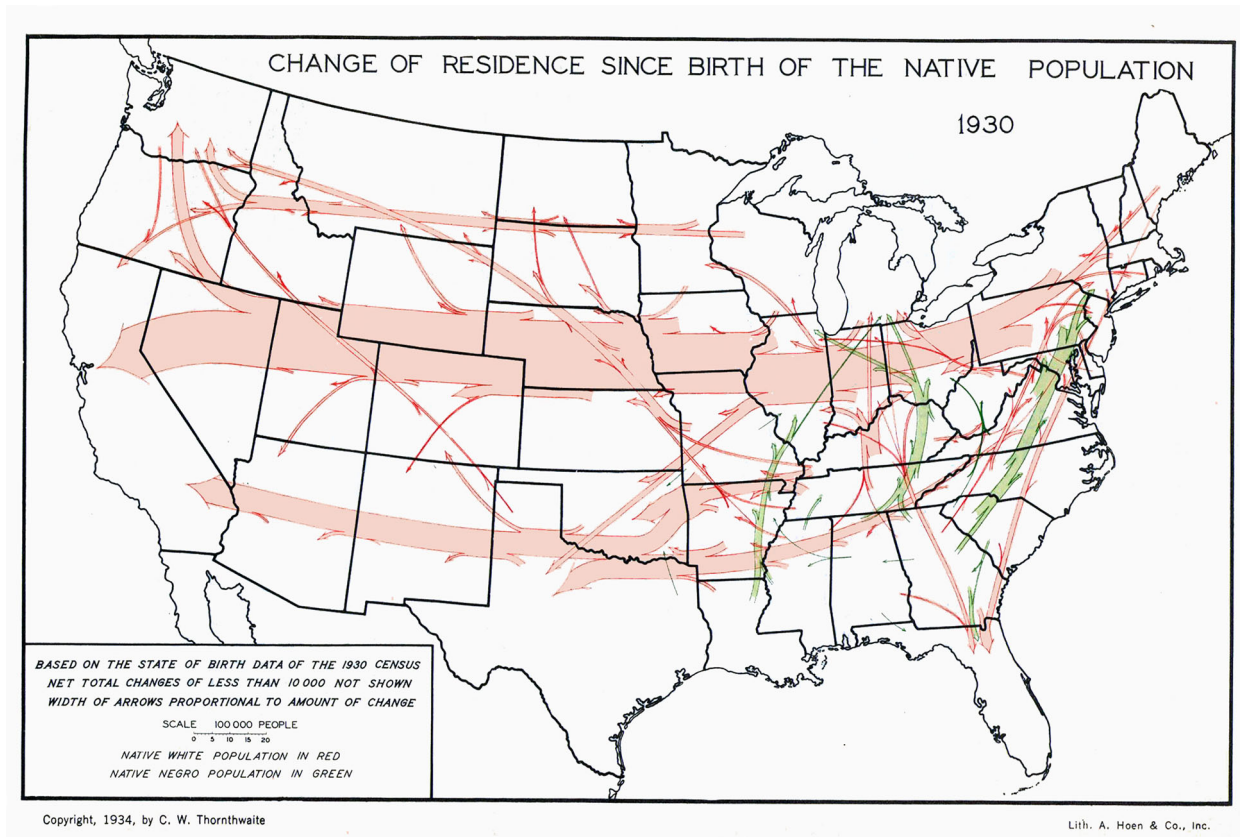
A review of flow maps by Segal (2020) highlights a map of grain exports by Schmidt and Heise in their 1927 atlas entitled *Welthandels-atlas: Produktion, Handel Und Konsum Der Wichtigsten Welthandelsgüter* [World trade atlas: production, trade and consumption of the most important world trade goods] (Figure 12). As Sefal notes, it is an example of flow maps becoming 'visual rhetoric', where their message becomes more focused. Although, a light shade of red is used for the arrows, the map appears tentative in its adoption of a blocky arrowhead at the end of each flowline, with thicker lines having a smaller arrow along their route.

Similarly, in the *Deutsche Landwirtschaftatlas* atlas of 1934, the thick curved arrow is embraced as a form of communicating statistical data (predominantly for the regional flows of agricultural products) (Figure 13). However, the maps are step away from Thornthwaite's clearly delineated lineweights, subtle colouring and arrowheads. Instead, and as with the *Welthandels-atlas* example (Figure 12), a descriptive legend is not provided and the line thicknesses are indicative rather than quantifiable. For example, while it is stated that a

Figure 7. Map by H.D. Harness showing passenger numbers on the railways of Ireland published in *Atlas to Accompany 2d Report of the Railway Commissioners Ireland 1838.* Reproduced courtesy of University College Dublin.

line width of 1 mm equals 30,000 tons, this is difficult in practice to relate to the map itself without visual examples for comparison.

The approach of regarding the meaning of arrows as implicit rather than explicit – as indicative rather than definitive – is an important development. It signalled a move away from the precise renderings of the pre-1930s to a more generalized style of arrow that was designed primarily to communicate a particular perspective or idea. This sleight of hand allows the mapmaker to utilize the cachet that comes with statistical maps as quantitative representations, but for persuasive reasons. It was adopted by German cartographers during an era of change in the way maps were created and used. In seeking to redress the humiliation of the Treaty of Versailles, maps

Figure 8. Map by C.J. Minard published in 1862 showing imports of woolen cotton to Europe in 1858 and 1861. Reproduced courtesy of the Library of Congress (control no.2004626057).

Figure 9. Map of population density and main migration flows, appearing in the *Geographic Atlas* (Part 1) of 1929, a school atlas that was compiled by M.I. Silishchensky and edited by N.N. Baransky and V.A. Kamenetsky. Reproduced courtesy of David Rumsey Historical Map Collection (list no. 13461.030).

Figure 10. Map from C.W. Thornthwaite's (1934) 'Internal Migration in the United States'. Thornthwaite is best known for his climate classification system, but the maps in this publication were its most notable feature. Reproduced courtesy of Widener Library, Harvard University (record ID: 990035065870203941).
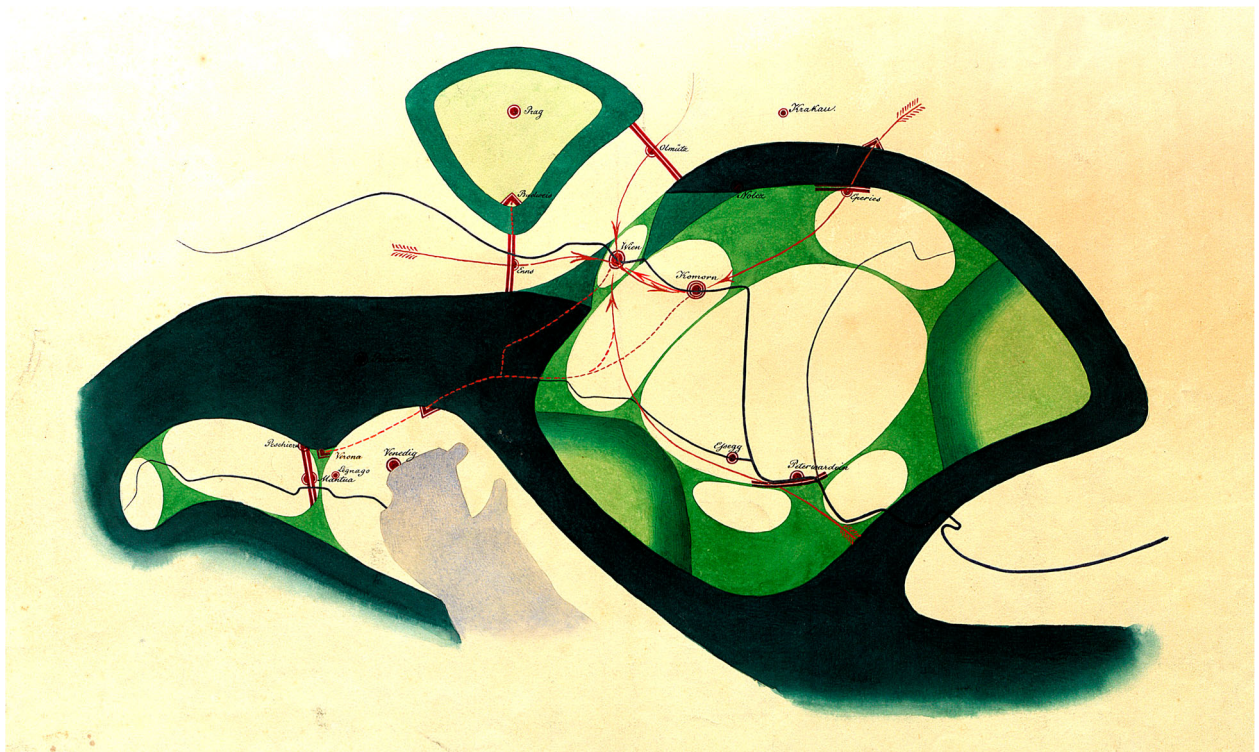
Figure 11. Franz Ritter von Hauslab's sketch map from around 1845, indicating the lines of potential attack on Vienna. The map also indicates the influence of terrain on conducting military operations, where the darker the green, the more unsuitable the terrain (Mokre, 2018). Reproduced courtesy of the Österreichisches Staatsarchiv, Kriegsarchiv, Karten- und Plansammlung: K VII a 52-1.
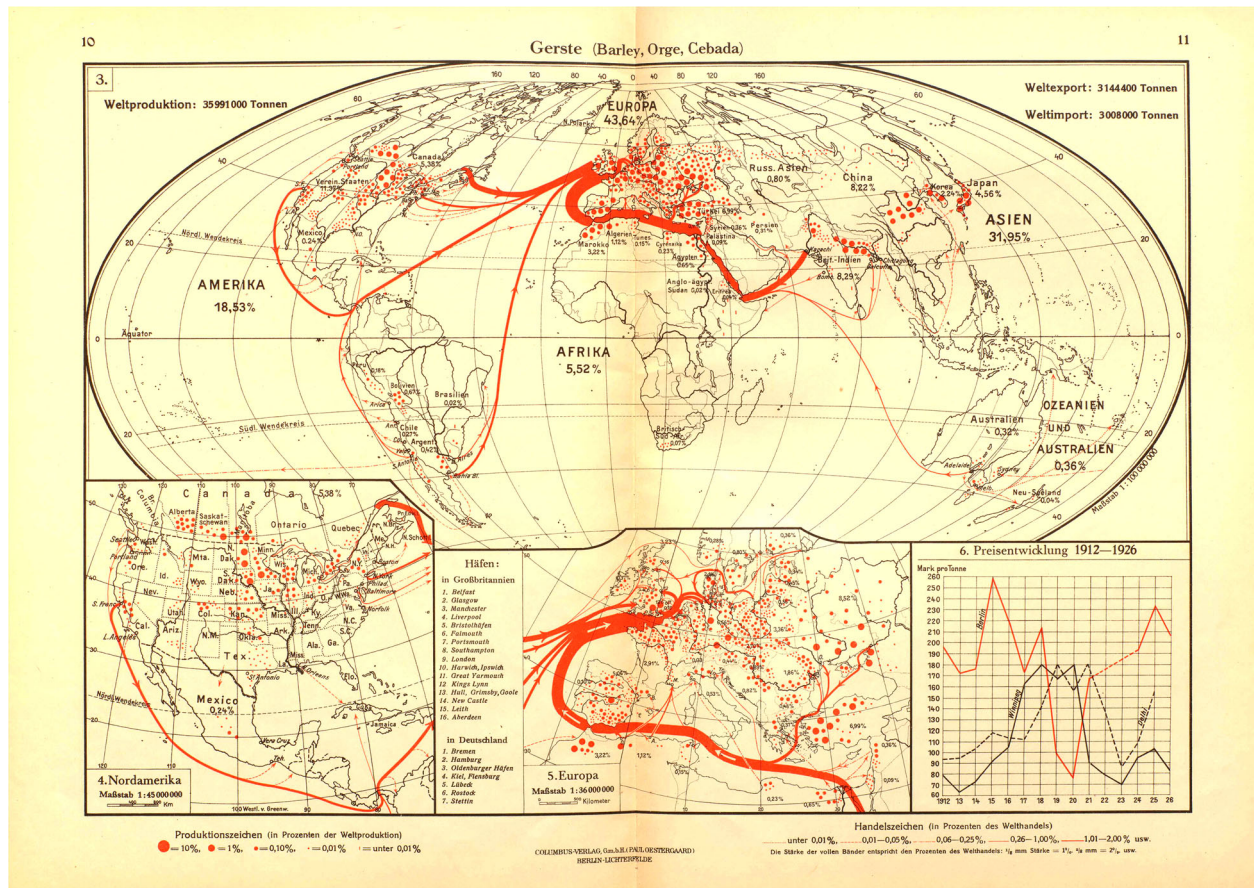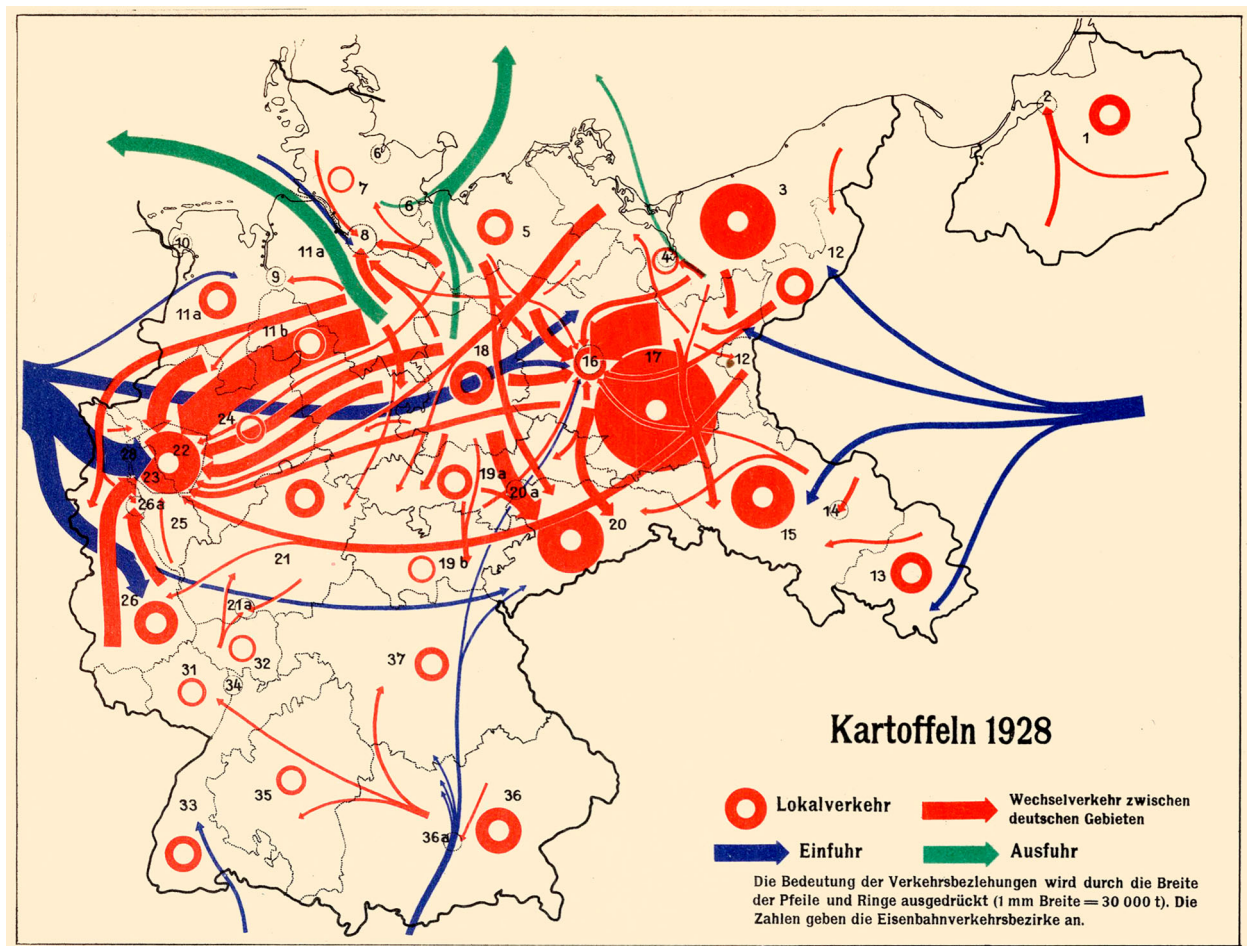
Figure 12. 'Gerste' in Walther Schmidt and Georg Heise, *Welthandels-atlas: Produktion, Handel Und Konsum Der Wichtigsten Welthandelsgüter* (Berlin: Columbus-Verlag, 1927). Reproduced courtesy of the Library of Congress (control no.84038020).

were seen to play a key role in transforming the national geopolitical narrative, and there was a move from scientific robustness and impartiality towards mapmaking for purely political ends (see Whittlesey, 1943; Herb, 1997). A crucial catalyst for this was the interwar *Geopolitik* of Karl Haushofer, who made a case for a more 'suggestive' cartography, saying that 'aspirations, as well as facts, are suitable subjects for maps' (Whittlesey, 1943: 94).

The message that readers took away from maps was hugely important to Haushofer and he promoted the development of a new cartography for his *Zeitschrift für Geopolitik* – a 'popular geopolitics' magazine whose articles laid the intellectual basis for much of what became Nazi ideology. Maps were used to articulate and justify the rationale for German expansion, such as *Drang nach Osten* (Urge to the East) and *Lebensraum* (Living space). For maximum effect, these maps had to be simple, demonstrate a clear message, and be cheap to produce in large quantities. Their design made regular use of bold, generalized arrows and their connotative power by suggesting, for example, the encirclement of Germany and thus conveying its vulnerability to attack from neighbouring states (Figure 14).
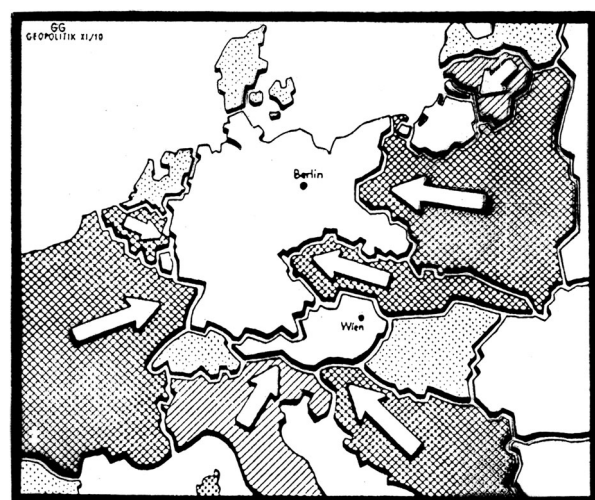
To develop this approach further, Schumacher's (1935) *Zur Theorie der geopolitschen Signatur* sets out in detail how map symbology should be deployed for explicitly geopolitical purposes. Particular attention is paid to arrows, where dozens of different variations are used. No fewer than sixteen types of arrow are proposed under the 'Attack, Sudden Advance – Struggle along a Basic Line' heading alone (see Figure 15), while a further fifteen are recommended for indicating 'Alliance, Merger, Union, Annexation, Struggle Towards Union', and ten more for 'Encirclement and Enclosure'. This particularly extensive symbology was discussed in detail by many geographers in the interwar years and studied closely by the Allies during the Second World War (see Cahnman, 1942; Whittlesey, 1943). There was a consensus that the symbology was both eye-catching and effective, which resulted in an explosion in the use of arrows – in particular – on maps depicting movements associated with war and national expansion.

Schumacher's work also represents one of the earliest declarations of the connotative power of maps for geopolitical messaging. It coincided with an increased use of arrows, especially those that combine both direction and line thickness to indicate magnitude, as discussed above. But more significantly, Schumacher's
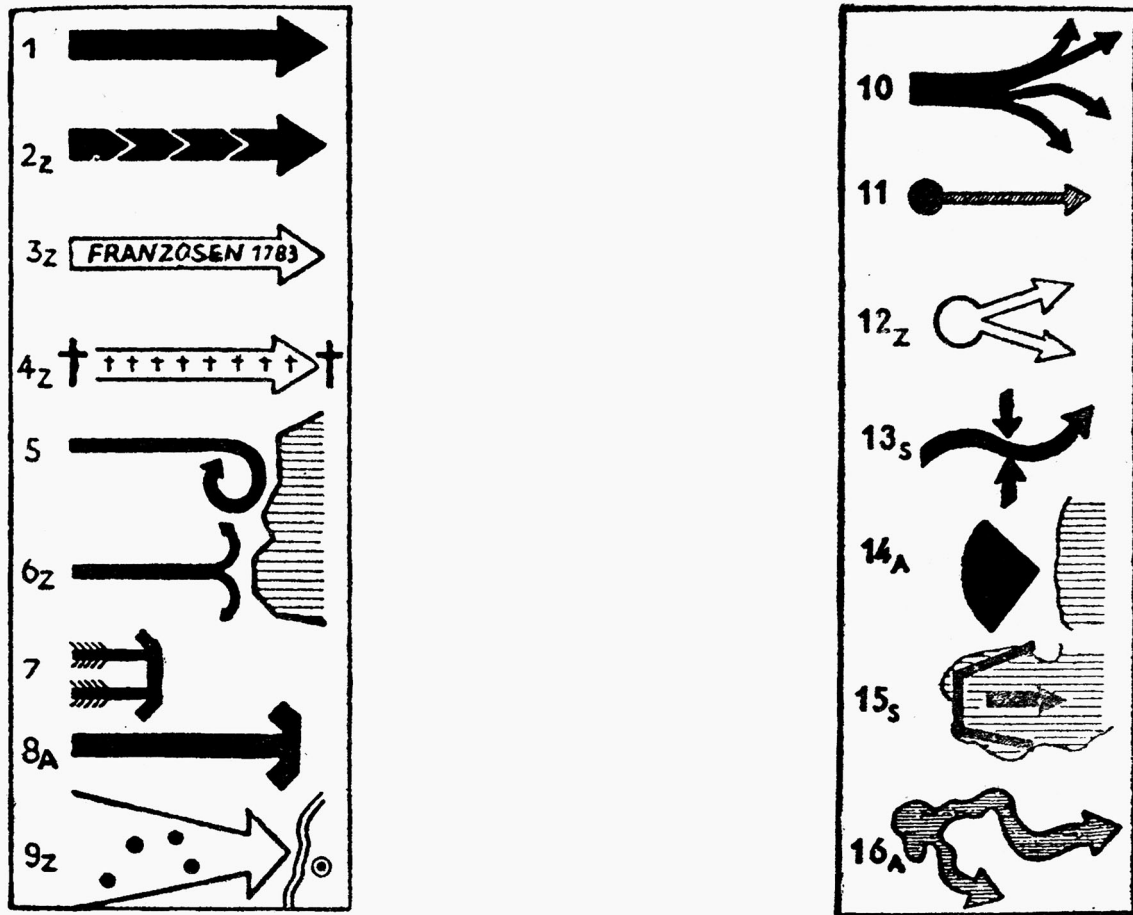
Kartoffeln 1928

○ Lokalverkehr — Wechselverkehr zwischen deutschen Gebieten

→ Einfuhr — Ausfuhr

Die Bedeutung der Verkehrsbezlehungen wird durch die Breite der Pfeile und Ringe ausgedrückt (1 mm Breite = 30 000 t). Die Zahlen geben die Eisenbahnverkehrsbezirke an.

Figure 13. One of a page of four maps from the *Deutsche Landwirtschaftatlas* (1934) showing the regional integration of agricultural markets, in this case for potatoes, in 1928. Arrows are coloured according to internal flows (red), imports (blue), exports (green). Reproduced courtesy of David Rumsey Historical Map Collection (list no. 14371.000).

expansion of the vocabulary of arrow symbols marked a deliberate transition away from the need to link arrow thicknesses to specific, quantifiable values. In this sense, the denotative function of the arrow was limited to indicating the general direction of movement between an origin and its destination. Through the introduction of more visual variables and graphical styles, Schumacher broadened the possibilities for arrows to express qualitative (nominal) characteristics and evoke a wider range of connotations.

This elaboration of arrow symbology did not mean that simpler forms became redundant. Indeed, simple arrows were used to suggest encirclement and vulnerability to Allied troops in order to break morale and encourage their surrender prior to their evacuation at Dunkirk in 1940 (Figure 16), even if they were seen instead by their recipients as a joke and provided a useful supply of toilet paper (Lord, 1998). Similarly, simple, bold arrows were used in newspapers and journals elsewhere to convey the latest developments in the war to a broad audience and give the impression of action and 'the will' of a nation. Figure 17 is an example from the *Seattle Post Intelligencer* that uses a combination of broad, dominant arrows and the colour red to illustrate the Japanese invasion of French Indo-China (Vietnam) in August 1941. As had become usual for this type of map, no quantities are given; the arrows purely indicate the act of invasion.

Figure 14. Schumacher's map showing the encirclement of Germany, appearing in *Zeitschrift für Geopolitik* (1934).

METHODS OF GEOPOLITICS   99

1

2z

3z FRANZOSEN 1783

4z

5

6z

7

8A

9z

10

11

12z

13s

14A

15s

16A

II.   Attack, Sudden Advance—Struggle Along a Basic Line.

1.   The arrow. This form of the arrow serves most efficiently. All forms that are curved or have any other character are not suited for precise presentation of a map picture. They seem affected and they can easily rob the map of its seriousness.

2.   A form of arrow indicating attack, presenting with unusual plasticity both the force of attack and the force of the movement. The arrow runs along like a movie film.

3.   The hollow arrow. It serves to box explanations which it is otherwise necessary to present outside the map in the legend.

4.   The hollow arrow in combination with a symbol relating to a thing. Here it illustrates the spread of Christianity.

5 and 6.   These two forms express the frustration of an attack.

7 and 8.   These two forms denote a frontal attack.

9.   The collective or areal arrow. Its gaping forks bring together, to a certain degree, a region whose total potentialities are engaged in attack. The example shows the direction of an attack by a league of cities.

10.   The radiating arrow. The splitting of an attack into different directions. The arrows must present the relation of the different currents of force. Their sum must equal the width of the main line. A graphic problem very often falsely handled.

11.   The planning arrow. It designates the adequacy of the plan of a movement. (Indicates centre of movement.)

12.   Illustration of attack starting from a particular region (area).

13.   Strangulation of one line of power by another—a flank attack.

14.   Mass attack with indication of the area to be attacked.

15.   Natural entry to an area. Direction of attack conditioned by the character of the area.

16.   Routes of attack. They show the course of movements through regions pre-destined by nature. (Arrows cartographically accurate.)

Figure 15. Whittlesey's (1943) translation of a page of Schumacher's (1934) *Zur Theorie der Geopolitschen Signatur* that illustrates a variety of arrow symbol designs and explains their use.

Figure 16. German propaganda leaflet dropped on Allied troops in Northern France and Belgium, 1940. Reproduced courtesy of Cornell University PJ Mode Collection of Persuasive Cartography (ID number 2217.01).

The use of arrows to suggest the threat of invasion posed during the Second World War even came to be used for comedic effect. Perhaps the most famous example is the opening animated sequence of *Dad's Army*, a popular television sitcom about the Home Guard produced by the BBC from 1968 to 1977 (Figure 18). This involves a triplet of British arrows proceeding southeast through northern France, only to be pushed back across the Channel by three advancing Nazi arrows with swastika-labelled arrowheads. The movement of these broad, curved arrows again portrays a particular national narrative, which is ironically countered by the show's defiant theme song, *Who do you think you are kidding, Mr Hitler?*. The series was originally intended to open with footage of refugees and Nazi troops as a reminder that the comedy was based on true events, although the Controller of BBC1 felt this was too insensitive for a comedy programme and ordered the sequence to be remade (BBC, 2010). Hence, by this time, the use of arrows was seen as a more innocuous symbol.

More recently, the connotations of invasion associated with a broad, sweeping arrow were used in 2016 by the VoteLeave campaign to imply the threat of uncontrolled immigration to the UK as a result of remaining within the European Union (Figure 19). In combination with the use of reds and oranges to highlight the threat posed by migrants entering the UK from certain Balkan countries, Turkey, Iraq and Syria, its creation indicates the confidence that th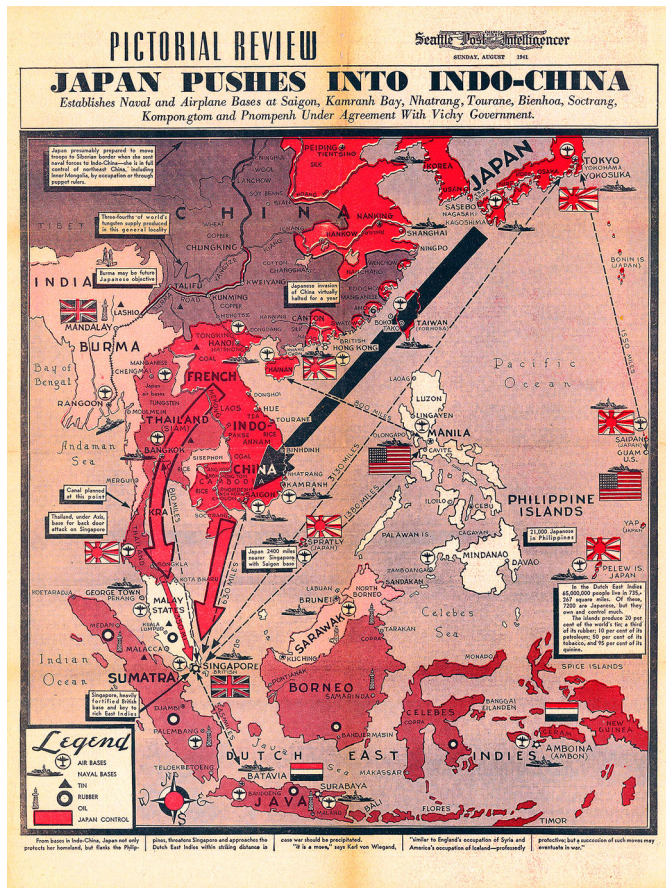e VoteLeave campaign placed in the use of arrows on maps to evoke a sense of threat and vulnerability that would persuade the electorate. Ultimately, the map demonstrates that knowledge of the connotative functions of propaganda mapping is alive and well (Kent, 2016).

Back to Ukraine

The overview above has shown that arrows on maps have a surprisingly rich history, which, perhaps more than any other commonly used cartographic symbol, blends quantitative with political applications. The use of arrows on maps to communicate the events that followed Russia's invasion of Ukraine also demonstrates this, and whilst the cartographers who created them may not have been consciously drawing on the symbol's graphical heritage, they have clearly been conditioned by its previous use.

Of course, we should not lose sight of what arrows on maps are being used to portray. An arrow denoting the trade of potatoes – as in Figure 13 – is not laden with connotation in the same way as one used to show the implied movement of people (as in Figure 19). Although mapping the flow of trade from one country to another might be motivated by geopolitics, it carries a lower risk of accompanying the threat-themed political rhetoric that surrounds the topic of migration.[1] This is why the suitability of using arrows to show the plight of Ukrainian refugees has been called into question (see also van Houtum and Bueno Lacy, 2020) and why cartographers should be motivated to find new visual forms for expressing the same data.

Nevertheless, it is important to acknowledge the specific constraints that mapmakers faced when covering the initial weeks of Russia's invasion of Ukraine. The first – and most important – is the detail and quality of the data available for mapping. The data were limited to just eight numbers capturing the journeys of those fleeing the crisis; the UN were able to release the figures for the numbers who had fled to seven neighbouring countries, plus everywhere else. There was no sense of where inside Ukraine refugees had come from, the border crossing points they had used, or their eventual destination. The second set of constraints is motivated by the need to create maps to convey events on the ground to the broadest audience possible. Nuance, uncertainty and detail cannot always be prioritized in such circumstances, and the message needs to be engaging, clear and unequivocal – priorities that do not always align well with rapidly developing events. Similarly, the final

Figure 17. 'Pictorial review: Japan pushes into Indo-China', a separate map accompanying the August 1941 edition of the *Seattle Post Intelligencer*. Reproduced courtesy of David Rumsey Historical Map Collection (list no. 9951.000).

constraint we consider here relates to how the maps were going to be consumed, for example, to accompany written articles, appear in feeds of live updates, across social media and on television broadcasts. This rules out the use of complex or unfamiliar symbology. A paucity of data and the need to reach a broad audience across a breadth of platforms are the same conditions that underpinned Schumacher's (1935) symbology guide that rallied against nuance and detail. New technologies – such as interactive maps and animations – are often regarded as the solution, but even today they remain impractical, especially since the data were not available to support their creation.

The initial maps (which is our focus here) that were created in response to the critique of arrows therefore coalesced around two strategies: removing the pointed arrowhead and/or softening the appearance of the arrows. Figure 20 illustrates four of these maps. That produced by the *Financial Times* (top left) retains the dynamism of the arrows by using a schematic tail (with a gradient applied) emanating from a proportional circle. The map shares actual numbers – as well as the total over Ukraine – and places the circles over the centre of each country, which conforms to the level of geographic precision

within the data. A common concern, however, is that simple forms such as these can never capture the depth and diversity of personal experiences and so it over-generalizes and sanitizes the situation (see e.g., Knowles *et al.*, 2015). The fear, the cold and the uncertainty are best shared through testimonies (such as those included in Du Bois, 1917), photographs and video, but visual reminders or tweaks to the symbols may be used to remind readers that they chart the movements of people (see Kelly, 2019). Ken Field (Figure 20, top right) responded with a map that breaks the arrows into dots to each represent 100 people, which softens the arrows a little and helps to visualize the sheer numbers of people encapsulated within each flow. Daniel Huffman (Figure 20, bottom left) suggested the use of isotypes to give a closer mimetic association with the subject of the map in conveying a sense of the migrant numbers. Although shorter arrows are included, the overall impact is less dramatic than sweeping arrows, but it indicates greater precision in the data than was available at the time and provokes further questions such as the gender or age breakdown of the refugees.

The final example from *The Economist* (Figure 20, bottom right) offers something of a combination of the two

strategies. Small icons give the immediate sense of people on the move, but are abstract enough for readers not to feel the map is devoid of detailed demographics. These icons are shown moving to the centre of proportional circles (showing the exact numbers of migrants) placed in each of the destination countries. Perhaps more significantly, the map does not use arrows for dramatic effect.

To determine which of these maps was more successful – in terms of the effective and suitable communication of their theme – would require a rigorous user study. However, in terms of the influence of these comparative solutions above, the map developed by the *Financial Times* was emulated and replicated elsewhere, not least by the BBC (Figure 21), and many others chose to emphasize the proportional circles and de-emphasize the arrows. This approach is the least radical; it continues to utilize

Figure 18. Still from the animated opening sequence of *Dad's Army*, 1968-1977. Reproduced courtesy of the BBC.

Figure 19. Map used by the Vote Leave campaign to persuade the electorate in the referendum on membership of the European Union (Vote Leave, 2016).

the familiar proportional symbols and uses lines of increasing thickness to suggest direction of movement, while blunting the arrowheads. The technique is therefore able to convey movement, direction and magnitude, without introducing the negative connotations associated with arrows that were amplified before, during and after the Second World War, particularly the threat of invasion. It is also more flexible, allowing a further enlargement of
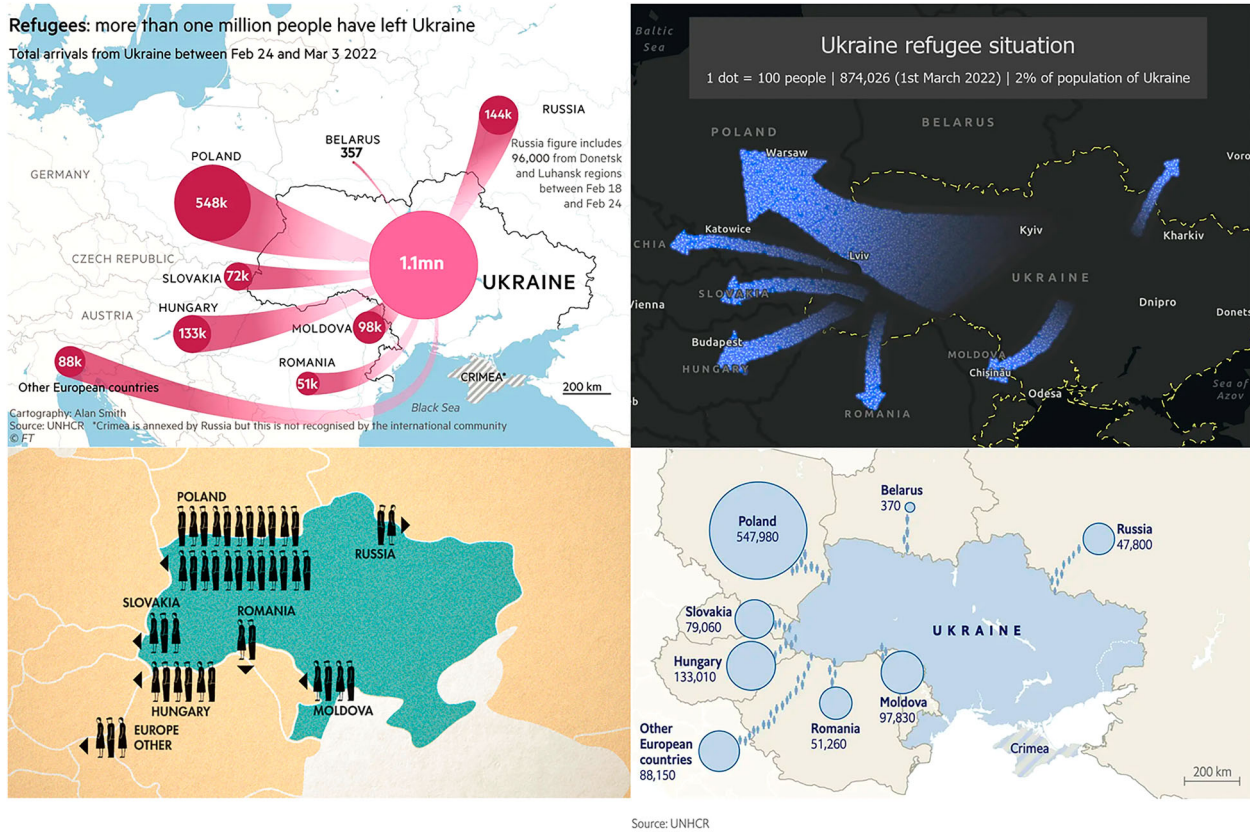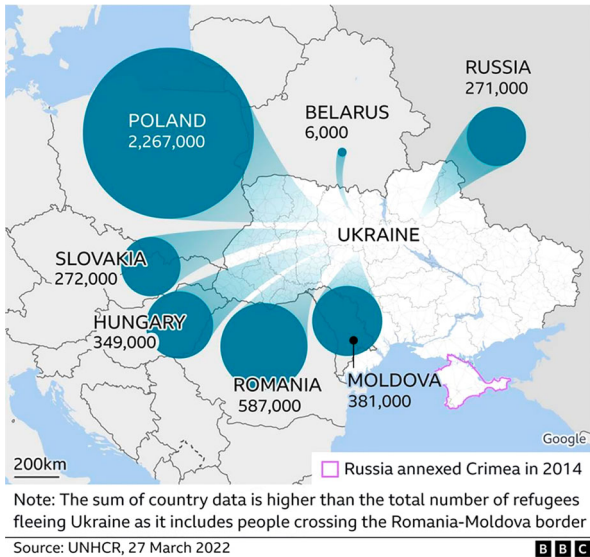

Figure 20. Four alternative maps produced in response to the initial critique of the use of arrows. From top left to bottom right: Alan Smith (*Financial Times*), Ken Field (Esri), Daniel Huffman, Economist Data Team.

More than 3.8m people have fled Ukraine

Figure 21. A later iteration of the BBC map (seen in Figure 1) that takes inspiration from the *Financial Times* design (bottom right example in Figure 20).

the symbols as the number of refugees increased, which is less viable with arrows that have effective limits on their width.

Conclusion

Maps stand apart from other forms of visual (and written) communication because they are not constrained by single, literal, ways of representing the world (Robinson and Petchenik, 1976). However, cartographic symbols that offer the most effective solutions for communicating directly, through the denotative and connotative possibilities they offer, tend to become more conventional and familiar. These established conventions can guide mapmakers in what works well and advise against what does not, for example, hydrological symbols are expected to be coloured blue (Seeholm, 2020). Nevertheless, a symbol's connotations, especially, change over time, and mapmakers need to be sensitive to these in deciding what is suitable for what is being portrayed.

Arrows are familiar symbols on maps and possess a sufficient cartographic heritage for minimizing misinterpretation. They have recently been used by news media outlets both for portraying invading troops as well as for the plight of refugees fleeing the horrors of war. However, as we have argued in this paper, cartography uses a visual language of expression, which needs to evolve in order to ensure that it is most effective, efficient and appropriate. If the capacity for cartographic creation, experimentation and dissemination is greater than ever before, mapmakers today should approach their design decisions with more flexibility and explore the possibility of forming new conventions for visualizing data on maps.

Note

1. See, for example, the recent controversy surrounding the language used by UK Home Secretary Suella Braverman, as reported in *The Guardian*, 14th January 2023 (Available at: *https://www.theguardian.com/world/2023/jan/14/suella-braverman-wont-apologise-to-holocaust-survivor-for-calling-migrants-invasion*).

Disclosure Statement

No potential conflict of interest was reported by the author(s).

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