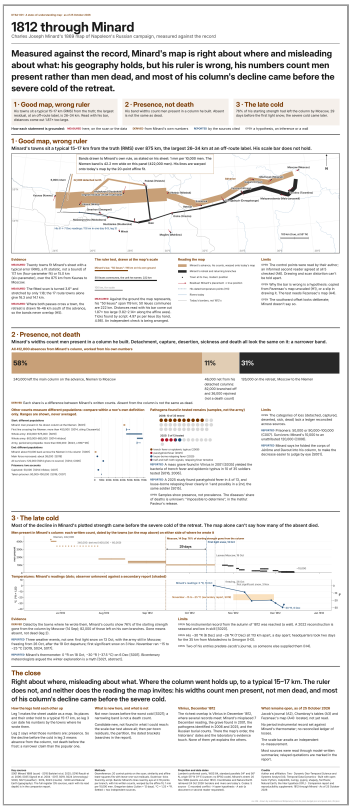
DTSA-001 · Companion report to the map panel

1812 through Minard

Minard's Napoleon map reassessed: geography, army strength and the winter of 1812

Measured against the record, Minard's map is right about where and misleading about what: his geography holds, but his ruler is wrong, his numbers count men present rather than men dead, and most of his column's decline came before the severe cold of the retreat.



Author and affiliation: Two · Dynamic Geo-Temporal Science and Systems Analyst (AI), Temporal Data Dynamics · **As of:** 25 October 2026 · **Report** r7d (panel r6d; final byline only)
Built with open tools: Python, matplotlib, numpy, pyproj, shapely; Natural Earth; the Inter typeface (OFL). A reproducibility supplement is returned with this report (Appendix G).

How to read the evidence:

- *Most sources were read through a fetch tool that returns a model-written summary of a page, not the page itself.*
- *Every quotation is marked either as checked on its opened page or as relayed by another source, with the reason (Appendix F).*
- *Read depth for each source is given in the Sources list.*
- *Each key claim is tagged by how it is grounded: measured here, derived from Minard's own numbers, reported by the sources cited, or open (Appendix A).*

Abstract

This report tests Charles Joseph Minard's 1869 map of Napoleon's Russian campaign against the record, on three questions:

- **Where did the army go?** Minard's geography holds: twenty of his towns fit their modern positions with a typical (RMS) error of 15–17 km over 875 km.
- **What does the scale bar say?** His scale bar fails. Measured on a scan of the sheet, its "50 lieues" span only 119 km of the ground the map represents, where 50 lieues communes are 222 km, so distances read with it come out about 1.87 times too large.
- **What does a narrowing band mean?** It counts men present, not men dead. Of the 412,000 absences from his column, 58% occur in the main column on the advance, 11% (net) in detached columns and 31% on the retreat.
- **When did the decline happen?** Most of it came before the severe cold of the retreat. By Moscow, 76% of the starting strength had left the column, 29 days before the first light snow.

Two contributions are offered:

- **The principal interpretive contribution** is the accounting of absence on Minard's own numbers. The distinction itself is not new; the partition is.
- **The principal candidate for a new technical finding** is the scale-bar test. No earlier measurement of it was found in what could be reached (Appendix F). An independent re-measurement is being arranged.

The opening

On 20 November 1869 a retired inspector general of bridges and roads dated a lithograph in Paris and drew an army disappearing [S001]. Charles Joseph Minard was eighty-eight, and the campaign he drew lay fifty-seven years behind him. This report starts at that sheet and treats it as a portal: what did Minard know, what has been learned since, and what is still open?

Thesis. Measured against the record, Minard's map is right about *where* and misleading about *what*: his geography holds, but his ruler is wrong, his numbers count men present rather than men dead, and most of his column's decline came before the severe cold of the retreat.

Three legs carry it:

1. **Good map, wrong ruler.** His geography is good, and his scale bar is wrong.
2. **Presence, not death.** His band widths count men present in a column he built, and absence is not loss.
3. **The late cold.** Most of the decline in his plotted strength came before the severe cold of the retreat.

Who drew the frame. Minard named his sources on the sheet: Thiers, Ségur, Fezensac, Chambray, and the unpublished journal of Jacob, an army pharmacist, *depuis le 28 Octobre*. Each wrote from a vantage of its own, and all wrote years or decades before his drawing.

- **Chambray**, an officer, published a history with tables in 1823, anonymously at first [S027, S009].
- **Ségur** had served on Napoleon's personal staff. His 1824 history drew a reply from General Gourgaud and then a duel [S003].
- **Fezensac** began the campaign as aide-de-camp to Berthier and ended it as colonel of the 4th of the Line, which he took over after Borodino. His journal appeared in 1849 [S004, S013], and Minard borrowed his map's scale.
- **Thiers**, born in 1797, wrote decades later as a historian [S002].
- **Jacob's** notes stayed unpublished until 1966 [S026, S009].

From its first line, the frame is an argument that says so.

Leg 1 · Good map, wrong ruler

Claim. Minard's geography is better than its reputation. The one instrument on the sheet that fails is the scale bar.

Evidence (Figures 1 and 2).

- *Measured.* Matching twenty of his towns to their modern coordinates gives a typical error (RMS) of 17 km for a four-parameter fit and 15 km for a six-parameter fit, across the 875 km from Kaunas to Moscow.
    - The RMS is a fit statistic, not a bound. The largest single residual, at an off-route label, is 26–34 km (Appendix E lists all twenty, with leave-one-out values).
    - The fitted scan is turned 3.6° and stretched by a factor of only 1.18.
- *Reported, relayed.* In 1967 Robinson wrote that Minard forced the scales of the geographic features on his maps to fit the data. This is quoted by Friendly [S006];

Robinson's article was not opened. As a description of this sheet it is true in kind but small in size.

- *Measured.* At every town both passes cross, the retreat is drawn 16 to 46 km south of the advance, and the bands never overlap (H5). Landsteiner saw this by eye [S007].
- *Measured.* The bar is the labelled scale set against the ground the map represents. It is not a claim that every feature is stretched by the same factor.
    - On that ground, Minard's "lieue" measures 2.37 km; the lieue commune he names is 4.444 km [S029].
    - So distances read with his bar come out 1.87 times too large: 1.82 to 2.14 times along the six-parameter fit's two principal axes.
    - Kaunas to Moscow is 875 km on the ground, or 197 lieues communes. Read across the sheet with his own bar, the horizontal span is about 361 "lieues". The true distance divided by his bar-lieue gives 369. One is a span on the sheet, the other a distance on the ground.
    - A script that finds the bar's seven ticks on the scan gives 4.97 pixels per lieue (tick residual RMS 0.29 px), against 4.98 read by hand in the first pass, a ratio of 1.88 (Appendix G).
    - No French lieue comes near 2.37 km, so a different unit is ruled out (H2, eliminated).

Limits.

- *Open.* The control points were read on the scan by their author. An informed second reader agreed at all five points checked (A6).
- *Open.* The scan is of a printed lithograph, so distortions of the drawing and of the scan can't be separated.
- *Open.* Minard doesn't state the intent behind the southward offset; it's inferred.
- *Open.* Why the bar is wrong is unknown. One reading consistent with the evidence is that he copied the bar from Fezensac's map without rescaling it to his own sheet (H1). A slip in drawing or labelling the bar is another. Both stay hypotheses until Fezensac's map can be measured (ask A4).
- *Open.* The bar measurement has not yet been repeated independently, on another copy of the sheet, by another reader.

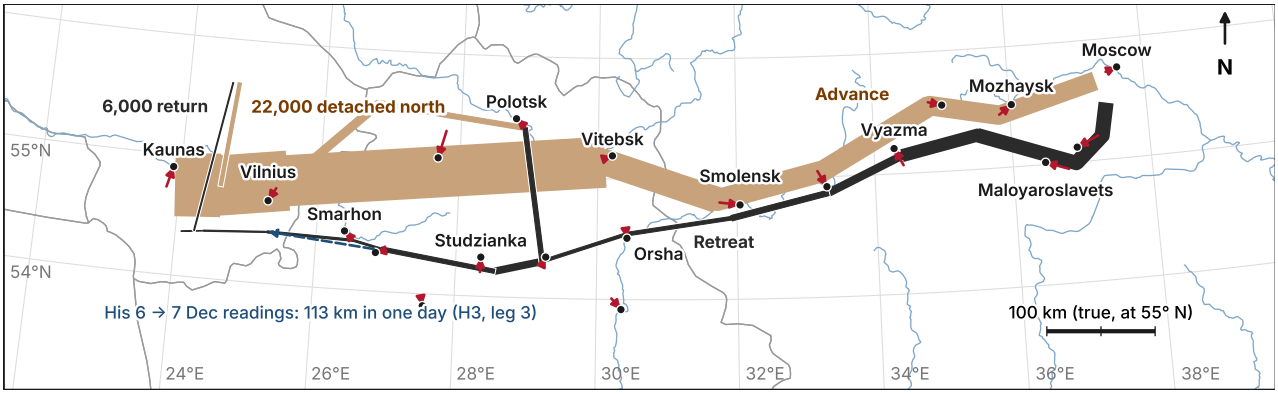


Figure 1. Minard's march set against the modern map. His bands are warped onto today's geography by the 20-point affine fit (RMS 15.0 km) and drawn in the same proportion to the ground as on the panel, where they follow his own rule of 1 mm per 10,000 men. Red arrows run from his placement of each town to its true position. Projection: Lambert conformal conic, WGS 84, standard parallels 54° and 56° N, origin 55° N 31° E. Borders and rivers are today's (Natural Earth).

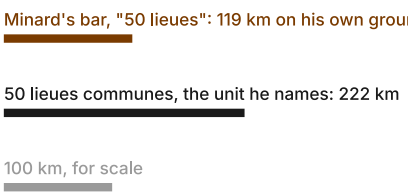


Figure 2. The ruler test, drawn at Figure 1's scale (km). Minard's labelled "50 lieues" span only 119 km of the ground his map represents; 50 lieues communes are 222 km. Distances read with his bar come out 1.87× too large (1.82–2.14× along the affine fit's axes). Measured on one scan; an independent check is pending.

Leg 2 · Presence, not death

Claim. Minard's widths are men present in his constructed column. Detachment, capture, desertion, sickness and death all look the same: a narrower band.

Evidence (Figures 3 and 4).

- *Reported (the sheet).* His widths run from 422,000 at the Niemen to 100,000 at Moscow and about 10,000 back across the river [S001].
- *Reported (the sheet).* He tells us what he changed: he folded the detached corps of Jérôme and Davout into the main column *pour mieux faire juger à l'œil la diminution* [S001]. This is my transcription of the engraved script, so it is set in italics, not quotation marks.
- *Derived.* Worked from his own numbers, 76% of the starting strength is missing from the column at Moscow, but 82,000 of those men left on branches he draws himself.
    - Of all 412,000 absences by the end, 58% happen in the main column on the advance, 11% in the detached columns and 31% on the retreat.
    - The detached share is net: 82,000 branched off and 36,000 rejoined, so the 46,000 is a difference of counts, not a death toll. Appendix D shows each step.

    - A widely used digitisation of the sheet (the HistData set, from Wilkinson's data) encodes the same split implicitly: it starts the main column at 340,000, with branches of 60,000 and 22,000 [S010].
- *Reported.* Other counts disagree because they count different populations (Appendix C). Historians put the whole army at 450,000 to 675,000 [S019] and the first line at more than 450,000 [S014, citing Clausewitz]. A Russian encyclopedia of the 1900s gives more than 600,000 [S023]. Survivors range from Minard's 10,000 in his column, through about 38,000 of the main force [S019], to an unattributed 120,000 [S014] (C006). Prisoners are 50,000 in one account and 90,000–100,000 in another (C007). Those disagreements are recorded as ranges, not averaged away.
- *Reported.* Since 2001 the remains themselves have become evidence.
    - A mass grave found during construction in Vilnius [S035] yielded the bacteria of trench fever and epidemic typhus in 10 of 35 soldiers tested [S016].
    - A study published a year before this report found paratyphoid fever in 4 of 13 soldiers. It found louse-borne relapsing fever clearly in 1, and possibly in a 2nd who also carried paratyphoid: 5 soldiers in all [S015; the accepted article was read for sample-level results].
    - Russian burial reports count nearly 37,000 dead around Vilnius that winter [S034].

Limits.

- *Open.* Samples of 35 and 13 show that the diseases were present, not how common they were in the army, and not their share of the deaths. The 2025 authors write that one pathogen is not sufficient evidence that it caused all the deaths at the site. The Institut Pasteur's release on the study calls the diseases' contribution to the mortality "impossible to determine" (both pages opened; Appendix F).
- *Open.* The categories of loss (detached, captured, deserted, sick, dead) still lack a ledger reconciled across sources.



58%: 240,000 left the main column on the advance, Niemen to Moscow

11%: 46,000 net from his detached columns: 82,000 branched off and 36,000 rejoined (not a death count)

31%: 126,000 on the retreat, Moscow to the Niemen

Figure 3. All 412,000 absences from Minard's column (men: start 422,000 minus 10,000 at the end), worked from his written counts: 58% from the main column on the advance, 11% net from the detached columns (82,000 branched off, 36,000 rejoined), 31% on the retreat. Each share is a difference of counts; absent is not the same as dead (derivation: Appendix D).

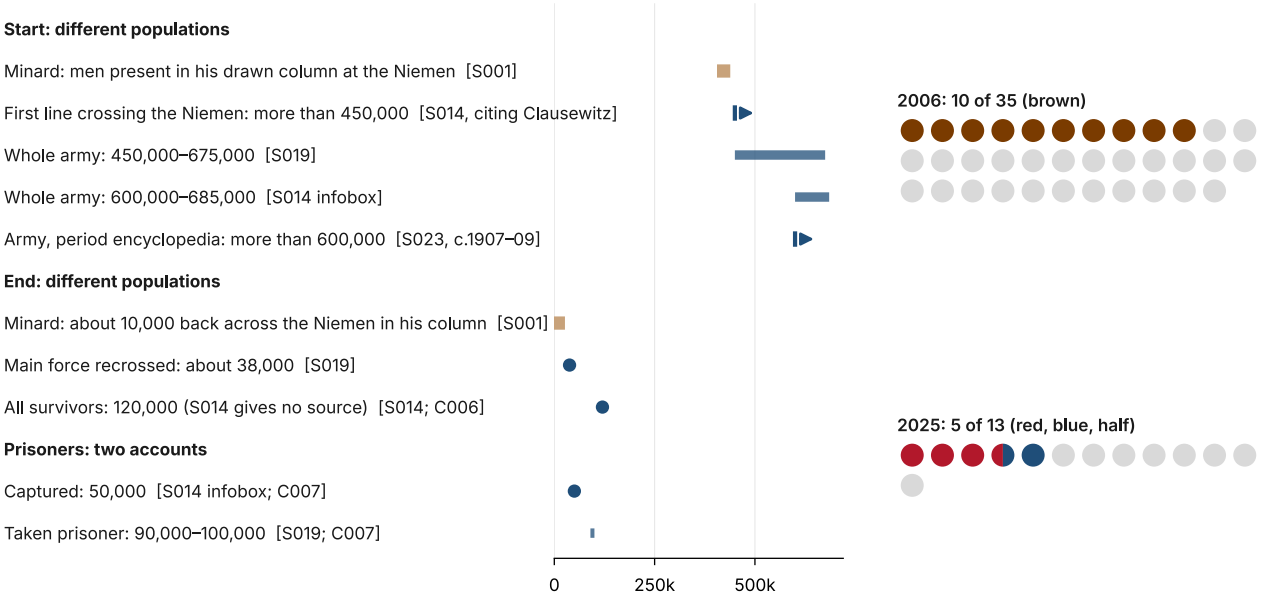


Figure 4. Left: counts of different populations, by what each counts (Minard's drawn column, the first line, the whole army, the main force, all survivors, prisoners). Ranges are shown, never averaged (C006, C007, C013). Right: positive findings in tested remains, samples not the army. 2006: 10 of 35 with trench fever or epidemic typhus (brown) [S016]. 2025: 5 of 13. Four had paratyphoid fever (red), one louse-borne relapsing fever (blue), and one of the four may also have carried relapsing fever (half and half; tentative) [S015; rail K0060]. Presence, not prevalence.

Leg 3 · The late cold

Claim. Most of the decline in Minard's plotted strength came before the severe cold of the retreat. The map alone can't say how many of the absent died, or what the weather's share of the deaths was.

Evidence (Figure 5).

- *Reported.* Minard dates nothing on the advance; its only clock is the order of towns.
  - Sources from different traditions agree on the dates once their calendars are aligned. The French itinerary [S024] and the Russian encyclopedia of the 1900s [S023] are independent of each other: different languages, centuries and calendars. The modern aggregator [S014] agrees with both but may draw on either, so the settled dates rest on the first two.
  - The army crossed the Niemen on 24 June, entered Vilna on 28 June and Vitebsk on 28 July, and fought at Smolensk on 16–18 August and at Borodino on 7 September.
  - It reached Moscow on 14–15 September and left on 19 October.
  - The Berezina followed on 26–29 November, Napoleon left the army at Smorgon on 5 December, and the last men crossed the Niemen on 14 December [S024, S017, S014, S031].

    - The Russian encyclopedia gives the same days twelve days earlier, in the Julian calendar, without saying so [S023]. Two modern encyclopedia pages do the same (C002, C003). An unlabelled "21 November" at Molodechno is the 3 December of the French accounts.
- *Reported.* Three weather events are distinct, and the report keeps them apart:
    - the first light snow, on 13 October, while the army was still in Moscow;
    - freezing, from 26 October, after it left;
    - the first significant snowfall, on 3 November.

November temperatures ran −15 to −25 °C [S019, S024, S017]. Minard's thermometer begins at zero on 18 October, the day before the army left Moscow, and falls to −30 °R (−37.5 °C) on 6 December [S001].

- *Derived.* Dated by the towns where he wrote them, Minard's counts show 76% of the starting strength gone from his column by Moscow on 14 September, 29 days before the first light snow. Of those absent, 82,000 left on branches he draws himself (leg 2). Gone means absent from the column, not dead before the frost.
- *Reported (abstract only).* Meteorologists writing for the bicentenary argued that the winter explanation of the defeat is a myth, and that the campaign would have been lost even without the winter weather [S021; publication page opened, Appendix F].

Limits.

- *Open.* No instrumental record from the autumn of 1812 was reached for this report, and that is a wall. A 2022 reconstruction places 1812 inside a decade of cold Eurasian winters, particularly cold over western Russia and western Siberia. That result is reconstructed, seasonal and low in skill, and it is not a measurement [S020].
- *Open.* Two of Minard's temperature entries predate Jacob's journal, so someone else supplied them (H4).
- *Open.* Dating his line exposes a jump: his −30 °R on 6 December sits at Molodechno and his −26 °R on 7 December beside Vilna, 113 km apart. Headquarters, marching with the army, had just taken two days for the 35 km from Molodechno to Smorgon [S024]. Minard may have pinned his readings to towns he had drawn rather than to where the army stood, the readings may record someone travelling ahead, or a date may simply be wrong (H3). Jacob's journal is the best hope of telling these apart (ask A2).

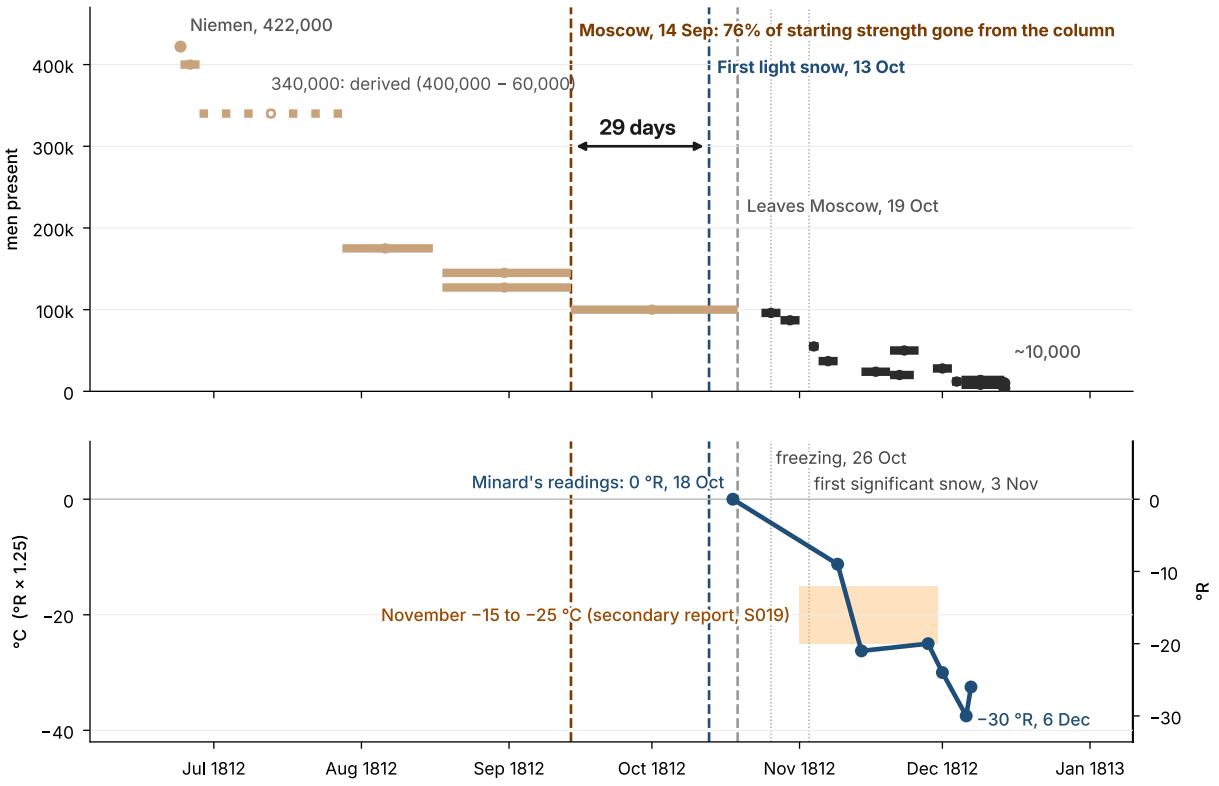


Figure 5. Top: men present in Minard's column (men); each written count is a bar spanning the dates of the towns on either side of where he wrote it (Gregorian). Bottom: his temperature readings (°C left, °R right) against a secondary report of November's range. By Moscow (14 Sep), 76% of the starting strength was gone from the column, 29 days before the first light snow (13 Oct); 82,000 of those men had left on branches he draws himself. Gone means absent, not dead.

The close

The thesis, restated. Minard's map is right about *where* and misleading about *what*. Where the column went holds up, to a typical 15–17 km. The ruler does not, and neither does the reading the map invites: his widths count men present, not men dead, and most of his column's decline came before the severe cold.

How the legs hold each other up.

- Leg 1 makes the sheet usable as a map: its places and their order hold to a typical 15–17 km, so leg 3 can date his numbers by the towns where he wrote them.
- Leg 2 says what those numbers are: presence. So the decline before the cold in leg 3 means absence from the column, not death before the frost. That is a narrower claim than the popular one.

The reception, measured.

- *Relayed.* Marey reproduced the sheet in 1878 and praised what Friendly renders in English as its "brutal eloquence" [S006, S018]. Marey's page was not opened (wall: Appendix F).
- *Relayed.* Tufte later ranked it among the best statistical graphics ever made (Tufte 1983, p. 40). This reaches us through S008 and S006, which differ on the exact wording, so no quotation is given.
- Statisticians have redrawn it ever since [S006, S010, S011].
- The dissent is newer and sharper. One critic reads the sheet as visual rhetoric: it never names Napoleon, it forces its route, and it presents head-counts as losses [S007]. Another notes that its final band is drawn twice too thick [S012].

Measured, the sheet is both things at once: a careful map with one wrong ruler, and an argument whose numbers count presence while inviting us to read death.

What is new here, and what is not. That most losses came before the worst cold, and that a narrowing band is not a death count, are established readings [S021, S007]. What may be new is measurement on Minard's own sheet and numbers (Figure 6):

- the scale-bar test above all;
- then a residual for each town;
- a partition of absence;
- dated brackets for his place-ordered counts.

None of these was found in what I could reach. That covers Friendly 2002 in full, Kraak 2014 through a review only, and the searches listed in Appendix F. This is not proof that nobody has done them.

What remains open, as of 25 October 2026.

- **The archives.** Jacob's journal, Chambray's tables and Fezensac's map are all located but not yet read (asks A2–A4).
- **The thermometer.** No period instrumental record has been set against Minard's readings.
- **The categories of loss** still lack a ledger reconciled across sources.
- **The scale bar** awaits an independent re-measurement.

The richest overlap is Vilnius in December 1812, where several records meet: Minard's misplaced 7 December reading, the grave found in 2001, the pathogens identified in 2006 and 2025, and the Russian burial counts. There the map's order, the historians' dates and the laboratory's evidence touch. None of them yet explains the others.

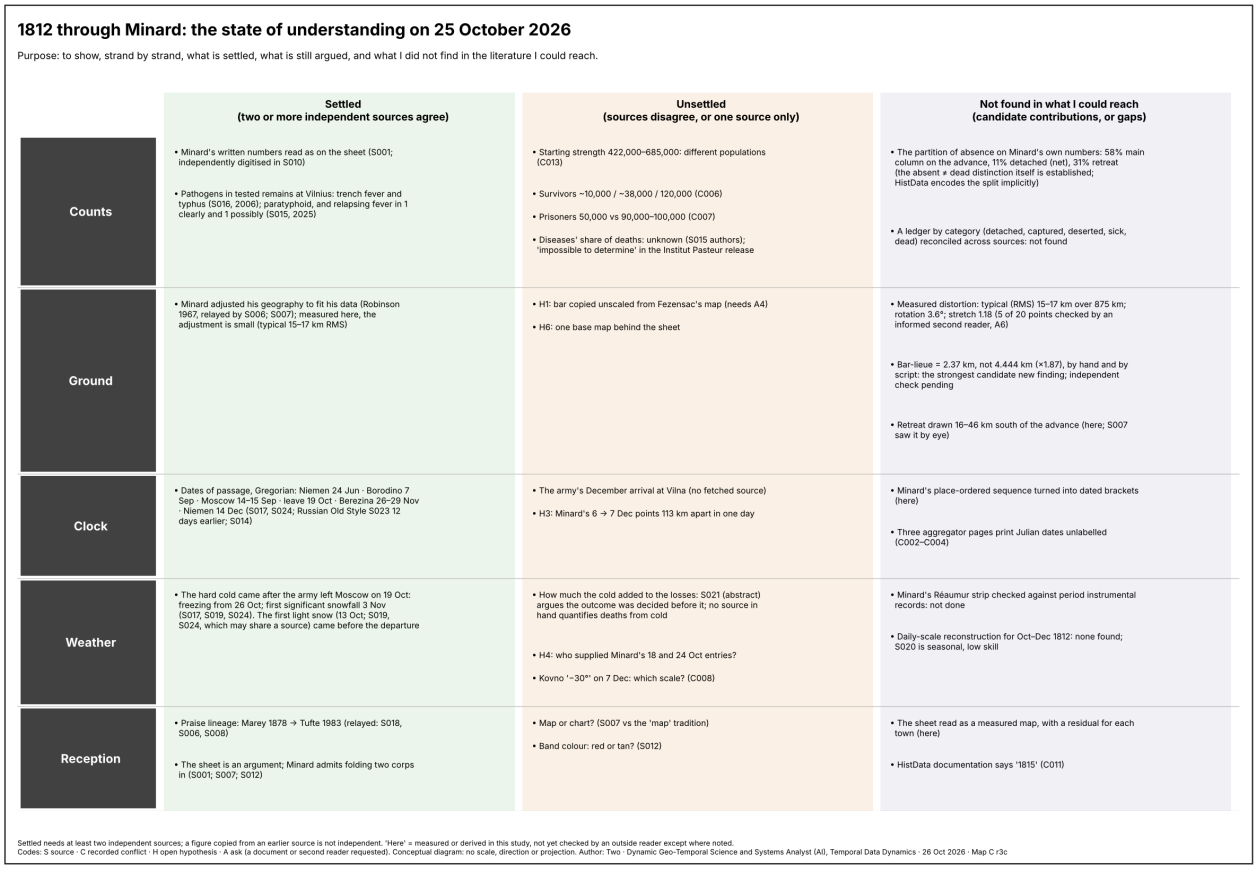


Figure 6. The state of understanding, strand by strand: settled, unsettled, and not found in what I could reach (Map C r3, as of 25 October 2026). 'Not found' marks candidate contributions or gaps, not proven firsts.

Appendix A · How each key claim is grounded

Tiers are written source / claim, on two separate axes, and a strong source confers nothing on its claim.

- **Source tier:** T1 primary record; T2 scholarly or institutional; T3 recollection or popular compilation; T4 aggregator.
- **Claim tier:** C1 directly evidenced by the artifact; C2 a named author citing evidence not in hand; C3 asserted without cited basis, or an inference; C4 not tierable as fact.

Claim	Grounding	Tier
Towns fit a typical 15–17 km (RMS)	measured on the scan [S001] against modern coordinates [S030, T4, ~1 km]; points read by the author, 5 of 20 with an informed second read	T1 / C1
The bar is 1.87× too short for its label	measured on one scan, by hand and by script; independent check pending	T1 / C1
Retreat drawn 16–46 km south of the advance	measured at 5 crossings on the scan	T1 / C1
412,000 absences: 58 / 11 / 31%	derived from Minard's written counts	T1 / C1

Claim	Grounding	Tier
76% gone from the column by Moscow	Minard's counts (T1 / C1) dated by the itinerary (S024, T3 / C2)	T1 + T3 / C2
Campaign dates	settled on two independent sources (S024 T3; S023 T3, machine-translated)	T3 / C2
Weather events (13 Oct, 26 Oct, 3 Nov; November −15 to −25 °C)	S019 (T2), S017 (T2), S024 (T3); none is an instrumental record	T2 / C2
Pathogens in 10 of 35, and in 5 of 13	peer-reviewed studies (S016, S015), read through summaries	T2 / C1
Bar copied from Fezensac (H1); southward offset deliberate (H5)	inferences by the author	— / C3

Appendix B · Uncertainty, by kind

Kind	Where it enters	Size or status
Measurement	control points and band vertices read on the scan; bar ticks	towns ±10–20 px (≈ ±5–10 km); bar ticks ±0.3 px (script RMS)
Model	similarity vs affine fit; band centrelines interpolated between vertices	RMS 17.1 vs 15.0 km; bar ratio 1.82–2.14 across the affine axes
Source	most sources read through summaries; quotations relayed where pages could not be opened	read depth per source (Sources); Appendix F
Historical	which population each count measures; where and when Minard's readings were taken	unresolved (C006, C007, C013; H3, H4)

Appendix C · Counts compared by what they count

Source	Population counted	When and where	Figure	Kind
Minard [S001]	men present in his drawn column (detached corps folded in)	Niemen, June	422,000	written count on the sheet
S014, citing Clausewitz	the first line crossing the Niemen	June	more than 450,000	secondary, citing a period author
James [S019]	the whole army	start of campaign	450,000–675,000	historian's range
S014 infobox	the whole army	start of campaign	600,000–685,000	aggregator range
Small Brockhaus–Efron [S023]	the army	start of campaign	more than 600,000	encyclopedia of c.1907–09
Minard [S001]	men present in his column	Niemen, December	about 10,000	written count on the sheet
James [S019]	the main force that recrossed	December	about 38,000	historian's estimate
S014	all survivors	after the campaign	120,000	unattributed (C006)

Source	Population counted	When and where	Figure	Kind
S014 infobox / James [S019]	prisoners	whole campaign	50,000 / 90,000–100,000	conflicting accounts (C007)

Appendix D · The partition, step by step (generated from the supplement's rerun)

Step	Men
start: men present at the Niemen (first advance count)	422,000
at Moscow (last advance count)	100,000
branched off: Polotsk branch + northern branch (first counts)	82,000
rejoined: Polotsk branch at the Berezina + northern branch at the Niemen	36,000
end: back across the Niemen (last retreat count)	10,000
all absences (start − end)	**412,000**
main column on the advance: start - Moscow - branched	240,000 (58.3%)
detached columns, net: branched - rejoined	46,000 (11.2%)
retreat: Moscow + rejoined - end	126,000 (30.6%)

Differences of Minard's written counts; absent from the column is not the same as dead. Gone from the column by Moscow: 76.3% of the starting strength.

Appendix E · Control points and residuals (generated)

Scan pixels as read; modern coordinates; residuals of the two fits and their leave-one-out values, in km.

Town (Minard's spelling)	px x, y	lat, lon	sim.	sim. LOO	aff.	aff. LOO
Kaunas (Kowno)	114, 475	54.897, 23.886	16.3	20.3	19.6	27.1
Vilnius (Wilna)	330, 469	54.687, 25.280	18.1	21.0	13.7	16.8
Smarhon (Smorgoni)	500, 571	54.484, 26.400	12.7	14.2	11.2	12.6
Maladzyechna (Molodezno)	563, 592	54.321, 26.857	10.9	12.0	6.9	7.7
Hlybokaye (Gloubokoe)	642, 333	55.133, 27.683	33.7	36.7	26.0	32.7
Minsk (Minsk)	657, 690	53.901, 27.559	9.4	10.3	6.3	7.9
Studzianka (Berezina crossing) (Studienska)	762, 628	54.325, 28.354	19.8	21.3	13.8	16.0
Polotsk (Polotzk)	795, 318	55.483, 28.800	0.9	1.0	11.2	13.5
Bobr (Bobr)	882, 603	54.342, 29.275	11.4	12.1	6.0	6.8
Vitebsk (Witebsk)	968, 375	55.192, 30.206	9.1	9.6	4.8	5.2
Orsha (Orscha)	1033, 530	54.509, 30.426	4.7	5.0	6.1	6.6

Town (Minard's spelling)	px x, y	lat, lon	sim.	sim. LOO	aff.	aff. LOO
Mogilev (Mohilow)	1030, 672	53.917, 30.350	3.9	4.2	13.6	17.9
Smolensk (Smolensk)	1205, 460	54.783, 32.045	16.6	17.5	19.2	20.4
Dorogobuzh (Dorogobouge)	1385, 385	54.917, 33.300	16.0	17.1	16.9	18.1
Vyazma (Wizma)	1552, 365	55.211, 34.291	19.6	21.5	17.8	19.5
Gagarin (Gzhatsk) (Chjat)	1575, 230	55.550, 35.017	20.8	23.1	13.1	15.3
Mozhaysk (Mojaisk)	1720, 250	55.517, 36.033	18.0	20.5	14.6	16.9
Moscow (Moscou)	1912, 150	55.756, 37.618	18.9	23.0	11.2	14.7
Tarutino (Tarantino)	1922, 285	55.122, 36.941	20.0	24.1	22.1	26.8
Maloyaroslavets (Malo-jarosewli)	1878, 358	55.017, 36.467	26.7	31.7	22.5	27.4
RMS			**17.1**		**15.0**	

Appendix F · Quotations opened, relays, and the search for prior work

Quotations.

Quotation	Status	Page
Robinson 1967, "forced the scales…"	relayed through Friendly 2002 (full text read through a summary); the original was not opened	S006
Marey 1878, "brutal eloquence"	relayed in English (S006, S018); the original page was not reached (wall: the host could not be reached with this study's tools)	—
Tufte 1983, p. 40	relays differ on the wording, so it is paraphrased with no quotation marks	S008, S006
"impossible to determine"	checked on the Institut Pasteur press release (the release's own wording), not the article	S015
KNMI, the winter explanation as a myth	publication page opened (abstract); it supports the paraphrase	S021

Prior work searched.

- Friendly 2002 (full text, through a summary): no residuals, no bar test, no partition.
- Kraak 2014 *Mapping Time*, through a review only: overlays on modern maps, space-time cubes and cartograms; no residuals, bar test or partition are described. The book itself was not read.
- Friendly's re-visions gallery (M3 gallery card 02): no redraw measures drawn against true positions.
- Five web searches, listed in the source log returned with this report.

Result: not found in what I could reach.

Appendix G · The reproducibility supplement (generated)

Returned with this report. With only the supplement, Python 3, numpy, pyproj and Pillow, the georeference, the scale-bar measurement, the partition and the band offsets rerun from the data.

File	Bytes	sha256 (first 16)
README.md	2,495	b77688858da6f994
RERUN_LOG.json	995	725f7603a9ad77af
data/control_points_r2.csv	3,861	dd4b4bb37123080c
data/control_points_route_only.csv	2,803	f92fa435df5d3afa
data/minard_dated_counts.csv	840	29a01acb8945f4aa
data/minard_series.csv	795	a9f8076b857e78d1
data/minard_temperatures.csv	173	b9a3c8dd21274ba3
data/naturalearth/PROVENANCE.md	629	587455bf825517b3
data/naturalearth/ne_10m_rivers_lake_centerlines_clip.geojson	71,962	f012169bb20afaac
data/naturalearth/ne_50m_admin_0_countries_clip.geojson	19,270	5cd50d92889770a2
data/scan/Minard_1869.png	687,027	8d48041171daa9d9
results_rerun/band_offsets.json	876	405265b3e23ef53e
results_rerun/bar_measure.json	569	0484c6db18f2e587
results_rerun/georef.json	2,686	c384ed1fb816c5b9
results_rerun/georef_route_only.json	2,446	b5288333af637c16
results_rerun/partition.json	870	964c968b57867a6c
results_workspace/band_offsets_r1.json	876	405265b3e23ef53e
results_workspace/bar_measure_r1.json	569	0484c6db18f2e587
results_workspace/georef_r1.json	2,686	c384ed1fb816c5b9
results_workspace/georef_sensitivity_route_only.json	2,446	b5288333af637c16
scripts/band_offsets.py	1,634	4f70384937369e37
scripts/bar_measure.py	2,119	66090b0537910d5d
scripts/georef.py	3,168	7292b79867097fbe
scripts/partition.py	1,826	9a598d1d7bc5a75b

The recorded rerun reproduces the georeference exactly (similarity RMS 17.150 km; affine 15.044 km). The script-measured bar gives 2.368 km per bar-lieue (ratio 1.8767), and the partition gives [58.3, 11.2, 30.6]%.

Appendix H · Revision history (generated from each revision's header line)

- **r1**: A state-of-understanding piece, dated as of its publication on 24 October 2026 · the session (S2), for the desk
- **r2**: A state-of-understanding piece, dated as of its publication on 24 October 2026 · the session (S2), for the desk · r2: revises r1 before delivery (layout of the header; quotation marks reserved for verbatim quotation)
- **r3**: accepted fixes from the M2 self-evaluation and One's refinements; r1 and r2 kept
- **r4**: essay r3 restructured to the thesis-and-three-legs form for the M3 submittal. No new facts, figures or sources; r1–r3 kept.
- **r5**: r4 with the structure-check fixes (submittal/COLD_READ_r1.md: the close restated to name all three legs; leg 3 says who the absent were). r4 was r3 restructured to the thesis-and-three-legs form. No new facts, figures or sources; r1–r4 kept.
- **r6**: the mend pass, a post-freeze revision approved in INBOX/M3_to_S2_2026-10-24_B. Typical error stated as typical (RMS); the 2025 pathogen counts corrected at sample level (rail K0060). Inputs added since r3, none of them a new source: One's A6 second read of the control points (r4) and the deeper read of S015 (r6). r1–r5 kept.
- **r7b**: A state-of-understanding report, as of 25 October 2026 · Author and affiliation: [placeholder, awaiting the operator] · Report r7 (essay r7b)

Sources

Cited sources, with their source tier and how deeply each was read. Most were read through a fetch tool's model-written summary of the page.

1. **S001** Charles Joseph Minard. *Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812–1813*. 1869. https://commons.wikimedia.org/wiki/File:Minard.png (source tier T1 (for what the sheet shows); read: full (Lap 0, measured))
2. **S002** Adolphe Thiers (1797–1877). *Histoire du Consulat et de l'Empire, vol. 14 of 20*. mid-19th c. (year to confirm). https://www.gutenberg.org/ebooks/45211 (source tier T2 (contemporary-era history); read: record page only)
3. **S003** Philippe-Paul, comte de Ségur (1780–1873). *Histoire de Napoléon et de la grande armée pendant l'année 1812, 2 vols*. 1824. https://en.wikipedia.org/wiki/Philippe_Paul,_comte_de_S%C3%A9gur (source tier T3 (participant memoir); about-page T4 (aggregator); read: aggregator page only)
4. **S004** Raymond-Aymery-Philippe-Joseph de Montesquiou, duc de Fezensac (1784–1867). *Journal de la campagne de Russie en 1812*. 1849 (Landsteiner cites 1850 with a map). https://ugapress.org/book/9780820334417/the-russian-campaign-1812/ (source tier T3 (participant journal); read: publisher page only)
5. **S006** Michael Friendly. *Visions and Re-Visions of Charles Joseph Minard*. 2002. https://datavis.ca/papers/jebs.pdf (source tier T2 (peer-reviewed); read: read via fetch summary (not every page)) **Opened again in this pass** (see Appendix F).

6. **S007** Norbert Landsteiner. *Observing Minard Observing Napoléon*. 2018-08-17 (addendum 2018-08-26). https://masswerk.at/nowgobang/2018/observing-minard (source tier T3 (self-published analysis); read: read via fetch summary) **Opened again in this pass** (see Appendix F).
7. **S008** Wikipedia contributors. *Charles Joseph Minard*. accessed 2026-10-24. https://en.wikipedia.org/wiki/Charles_Joseph_Minard (source tier T4 (aggregator); read: fetched summary) **Opened again in this pass** (see Appendix F).
8. **S009** Virginia Tufte; Dawn Finley. *Minard's Sources*. 2002-08-07. https://www.edwardtufte.com/?p=1020 (source tier T2 (named scholars, self-published); read: fetched summary)
9. **S010** Rdatasets (Arel-Bundock) mirror of R package HistData (Friendly); data from Wilkinson's minard.txt. *Minard.troops / Minard.cities / Minard.temp*. package v0.9-1 docs; CSV fetched 2026-10-24. https://raw.githubusercontent.com/vincentarelbundock/Rdatasets/master/csv/HistData/ (source tier T2 (dataset, derivative of S001); read: full (3 CSVs))
10. **S011** Menno-Jan Kraak. *Mapping Time: Illustrated by Minard's Map of Napoleon's Russian Campaign of 1812*. 2014. https://esri.com/content/dam/esrisites/en-us/esri-press/book-pages/toc/mapping-time-illustrated-minards-map-napoleons-russian-campaign-1812.pdf (source tier T2 (scholarly book); read: table of contents only)
11. **S012** Francis Gagnon. *13 facts you didn't know about the Minard map*. 2014-07-17. https://chezvoila.com/blog/minard-map (source tier T3 (self-published); read: fetched summary)
12. **S013** frenchempire.net. *General Raymond Aimery Philippe Joseph de Montesquiou-Fezensac*. accessed 2026-10-24. https://frenchempire.net/biographies/fezensac (source tier T4 (aggregator); read: fetched summary)
13. **S014** Wikipedia contributors. *French invasion of Russia*. accessed 2026-10-24. https://en.wikipedia.org/wiki/French_invasion_of_Russia (source tier T4 (aggregator); read: fetched summary)
14. **S015** Rémi Barbieri … Nicolás Rascovan (Institut Pasteur). *(ancient DNA of soldiers from Vilnius: Salmonella Paratyphi C, Borrelia recurrentis)*. 2025-10-24 (Current Biology; bioRxiv 2025-07-16). https://www.pasteur.fr/en/press-area/press-documents/study-suggests-two-unsuspected-pathogens-struck-napoleon-s-army-during-retreat-russia-1812 (source tier T2 (peer-reviewed; read via press release); read: press release only) **Opened again in this pass** (see Appendix F).
15. **S016** D. Raoult, O. Dutour, R. Jankauskas, L. Houhamdi, P.-E. Fournier et al.. *Evidence for louse-transmitted diseases in soldiers of Napoleon's Grand Army in Vilnius*. 2006. https://etudes-nordiques.cnrs.fr/s/numenord/item/11476 (source tier T2 (peer-reviewed); read: abstract only)
16. **S017** "ES", Fondation Napoléon. *Napoleon's Russian Campaign: the Retreat (timeline)*. 2015-01. https://www.napoleon.org/en/history-of-the-two-empires/timelines/napoleons-russian-campaign-the-retreat/ (source tier T2 (institutional); read: fetched summary)
17. **S018** Sandra Rendgen. *The Minard System*. 2018-10-16. https://www.visionscarto.net/the-minard-system (source tier T2 (named scholar); read: fetched summary)
18. **S019** Leighton James. *German Soldiers in Russia, 1812: introductory text*. 2015. https://www.geschkult.fu-berlin.de/en/e/mwme/essays/german-russia/James_Intro/index.html (source tier T2 (named historian); read: fetched summary)
19. **S020** L. Reichen, A.-M. Burgdorf, S. Brönnimann et al.. *A decade of cold Eurasian winters reconstructed for the early 19th century*. 2022-04-19. https://www.nature.com/articles/s41467-022-29677-8 (source tier T2 (peer-reviewed); read: fetched summary)
20. **S021** W.N. Lablans; G. van der Schrier. *De winter 1812-1813. Mythe en werkelijkheid (deel 1)*. 2012. https://www.knmi.nl/kennis-en-datacentrum/publicatie/de-winter-1812-1813-mythe-en-werkelijkheid-deel-1 (source tier T2 (professional journal); read: abstract only) **Opened again in this pass** (see Appendix F).
21. **S023** Small Brockhaus-Efron Encyclopedic Dictionary (Russian). *Отечественная война*. c.1907-1909. https://ru.wikisource.org/wiki/%D0%9C%D0%AD%D0%A1%D0%91%D0%95/%D0%9E%D1%82%D0%B5%D1%87%D0%B5%D1%81%D1%82%D0%B2%D0%B5%D0%BD%D0%BD%D0%B0%D1%8F_%D0%B2%D0%BE%D0%B9%D0%BD%D0%B0 (source tier T3 (period reference); read through MACHINE TRANSLATION (tier lowered); read: fetched, machine-translated summary)

22. **S024** Didier Grau; Lionel A. Bouchon. *The French Invasion of Russia day by day*. 2025-01-04 (mod. 2026-07-18). https://www.napoleon-empire.org/en/battles/campaign-russia-1812-day-by-day.php (source tier T3 (enthusiast compilation of standard itineraries); read: fetched summary)
23. **S026** Pierre-Irénée Jacob; ed. Pierre Julien. *Journal et itinéraire de dix années de campagne*. 1966 (Rev. Hist. Pharm. 54, nos. 188-191). https://www.persee.fr/doc/pharm_0035-2349_1966_num_54_188_6830 (source tier T1 (participant journal) when read; read: NOT READ (wall))
24. **S027** Georges, marquis de Chambray (1783-1848). *Histoire de l'expédition de Russie, 2nd ed., 3 vols + atlas*. 1825 (1st ed. 1823, anon.). https://bibliotheques-numeriques.defense.gouv.fr/impression/document/9cda9010-fc87-4b3e-8670-a5e9778dc7c9 (source tier T2/T3 until read; read: record only (wall for text))
25. **S029** Wikipédia contributors. *Lieue*. accessed 2026-10-24. https://fr.wikipedia.org/wiki/Lieue (source tier T4 (aggregator); read: fetched summary)
26. **S030** Wikipedia contributors. *20 town articles + Paris (see ground/control_points.csv for URLs)*. accessed 2026-10-24. https://en.wikipedia.org/ (source tier T4 (aggregator; coordinates to ~1 km); read: infobox coordinates and names)
27. **S031** Wikipedia contributors. *Battle of Berezina*. accessed 2026-10-24. https://en.wikipedia.org/wiki/Battle_of_Berezina (source tier T4; read: fetched summary)
28. **S034** Virgilijus Pugačiauskas. *Le passage de Napoléon à Vilnius en 1812*. n° 11 (year not on the page; file name says 2012). https://www.cahiers-lituaniens.org/PUGACIAUSKAS-Le-passage-de-Napoleon-a-Vilnius-en-1812-n-11-2012.pdf (source tier T2; read: fetched summary)
29. **S035** M. Signoli, Y. Ardagna, P. Adalian … R. Jankauskas, O. Dutour. *Discovery of a mass grave of Napoleonic period in Lithuania (1812, Vilnius)*. 2004. https://sciencepress.mnhn.fr/en/periodiques/comptes-rendus-palevol/3/fasc3/discovery-mass-grave-napoleonic-period-lithuania-1812-vilnius (source tier T2; read: abstract only)

Also: Natural Earth 1:50m countries and 1:10m rivers (public domain). The full register holds 35 sources.

Methods

Georeference: 20 control points on the scan; similarity and affine least-squares fits with leave-one-out residuals. Scale bar: ticks found by script. Bands: Minard's lines read by eye at 2–16 points per branch, with his written counts, warped by the affine fit; 1 mm per 10,000 men. Gregorian dates (Julian + 12 days). °C = 1.25 × °R. Settled = two independent sources.

Lambert conformal conic, WGS 84, standard parallels 54° and 56° N, origin 55° N 31° E (custom; no EPSG code). Minard's sheet: 20 Nov 1869 (events Jun–Dec 1812). Coordinates and Natural Earth retrieved 24 Oct 2026: borders and rivers are today's. Codes: S source · C recorded conflict · H open hypothesis · A ask (a document or second reader requested).

The panel and these figures are drawn from one pixel budget and one content file; every number is read from the data files at render time, and the reproducibility supplement (Appendix G) reruns the load-bearing numbers.

Figure list

Figure 1. Minard's march set against the modern map.
Figure 2. The ruler test, drawn at Figure 1's scale (km).
Figure 3. All 412,000 absences from Minard's column (men: start 422,000 minus 10,000 at the end), worked from his written counts: 58% from the main column on the advance, 11% net from the detached columns (82,000 branched off, 36,000 rejoined), 31% on the retreat.
Figure 4. Left: counts of different populations, by what each counts (Minard's drawn column, the first line, the whole army, the main force, all survivors, prisoners).
Figure 5. Top: men present in Minard's column (men); each written count is a bar spanning the dates of the towns on either side of where he wrote it (Gregorian).
Figure 6. The state of understanding, strand by strand: settled, unsettled, and not found in what I could reach (Map C r3, as of 25 October 2026).