

Map Projections:

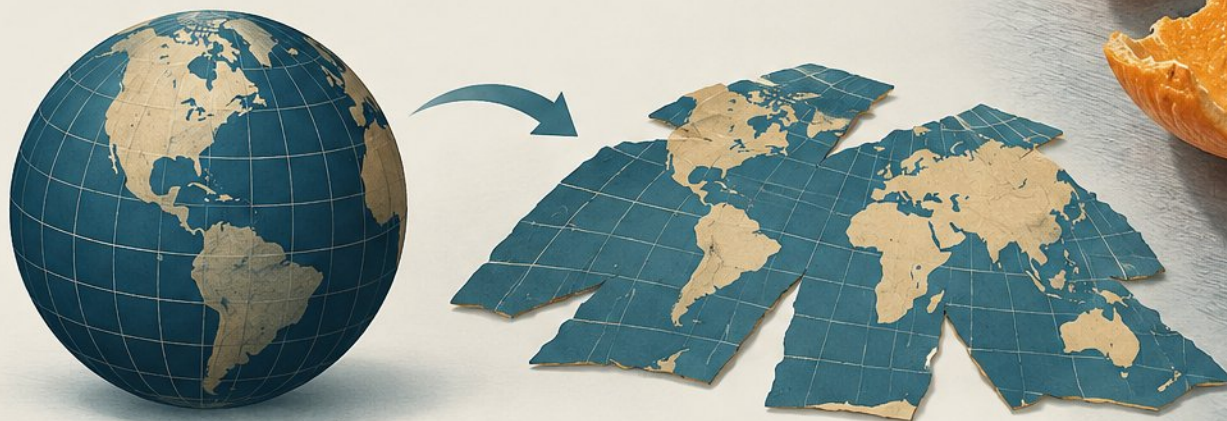
Why Every World Map Distorts

- Every flat world map is a purposeful compromise, not a true portrait of Earth
- A sphere cannot be flattened without stretching, tearing, compressing, or shearing
- Guiding question: what gets distorted, where, and why does it matter?
- You will identify four distortion types and choose projections by purpose
- In 2026 the UN endorsed Equal Earth and equal-area maps, reviving map literacy



Why Flattening a Sphere **Cannot** Be Correct

- Earth is an oblate spheroid; a plane is flat
- Gauss's Theorema Egregium (1827): curvature cannot bend away
- The orange-peel test: flattening tears or stretches
- Distortion is mathematically compulsory, not a design flaw



The Four Properties Every Map Must **Trade Away**

SAME WORLD
DIFFERENT VIEWS

Area



Are countries shown at true relative size?

Shape



Do coastlines and borders keep correct outlines?

Distance



Are distances between locations measured correctly?

Direction



Are compass bearings preserved?

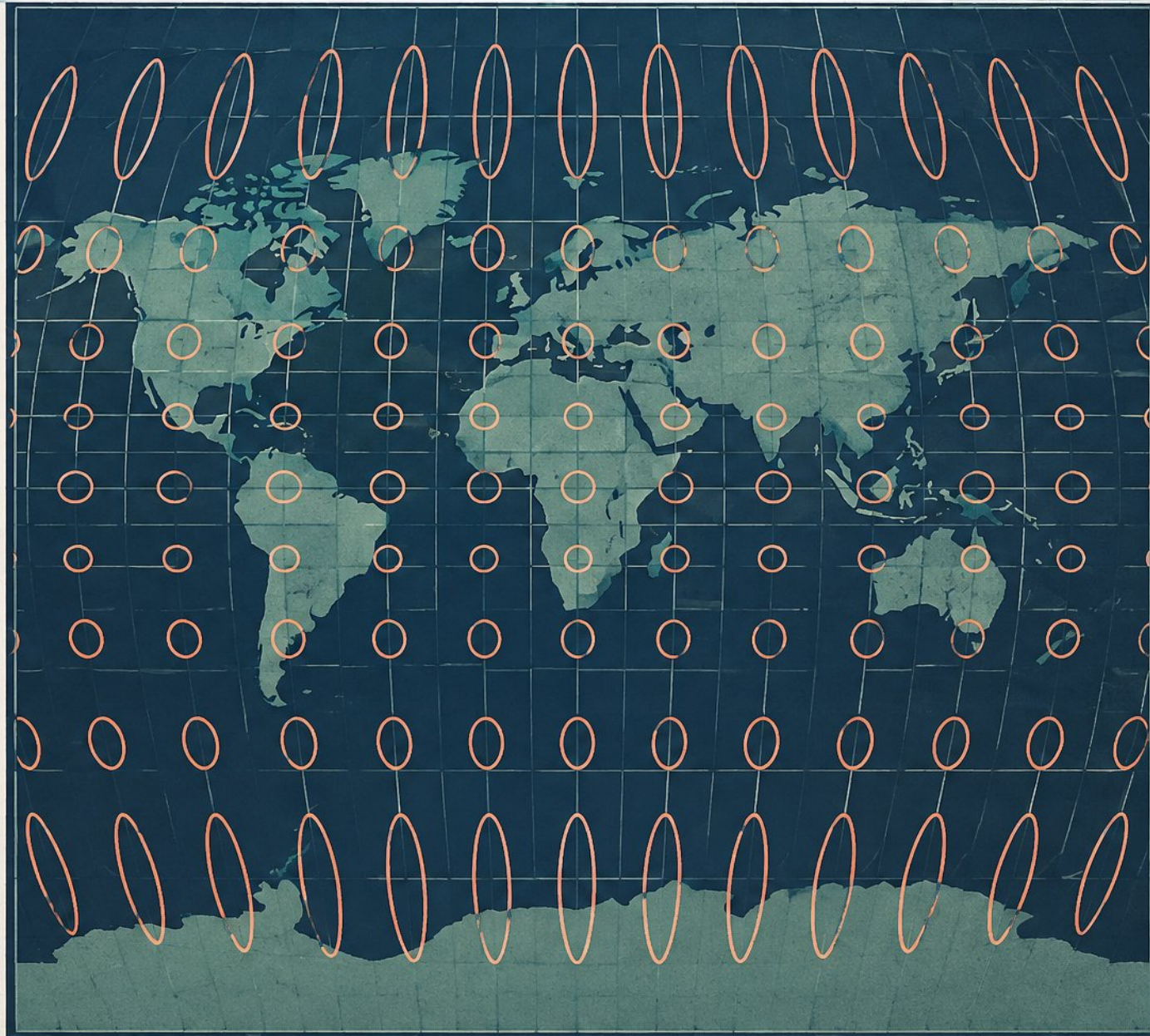
Families: conformal, equal-area, equidistant, compromise

No projection preserves all four — mathematically impossible

MAPS REVEAL
CHOICES
NOT JUST PLACES

Tissot's Indicatrix: Seeing Distortion at a Glance

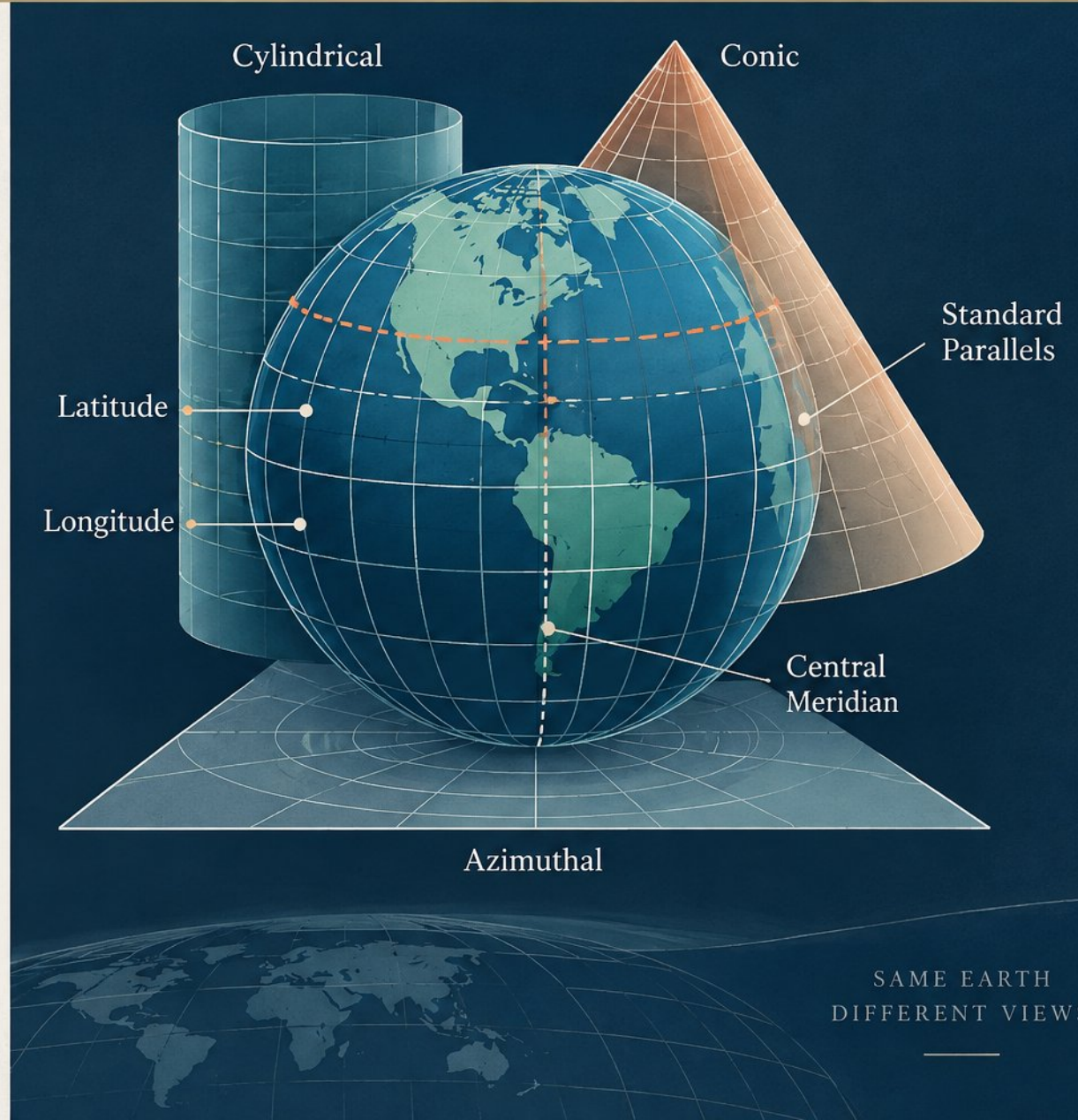
- Tissot (1859): equal circles on the globe become ellipses on the map
- Circles stay circles = conformal; ellipses of equal area = equal-area
- Both size and shape vary = compromise projection
- Mercator: circles grow toward the poles, revealing areal inflation
- Equal-area maps: stretched ellipses expose shape distortion
- Indicatrix is a local, point-level diagnostic; overlay many to see patterns



From Globes to Grids: How Projections Are Built

MAPS
CONNECT
OUR WORLD

- Latitude and longitude locate points; WGS84 provides the reference ellipsoid
- Three classical families: cylindrical, conic, azimuthal — each fits a region best
- Aspect rotates the surface: normal, transverse, or oblique
- Standard parallels and central meridians control where distortion is minimized
- Distortion grows away from tangency; nothing fits all purposes
- Caveat; cylinder-cone-plane is a mental model, not every modern projection



The Usual Suspects: Mercator, Gall-Peters, Robinson, and Winkel Tripel



Mercator



Gall-Peters



Robinson



Winkel Tripel



- **Mercator (1569)**: conformal; straight rhumb lines for navigation; inflates high-latitude areas
- **Gall-Peters**: equal-area; true relative sizes, but visibly stretched shapes near poles
- **Robinson (1963)**: compromise; balances size and shape for pleasing world maps
- **Winkel Tripel (1921; adopted by National Geographic in 1998)**: compromise minimizing overall distortion
- Mercator was built for maritime navigation—its classroom dominance was unintended

What Distortion Looks Like: Greenland, Africa, and Beyond

SAME MAP. A DIFFERENT PERSPECTIVE.

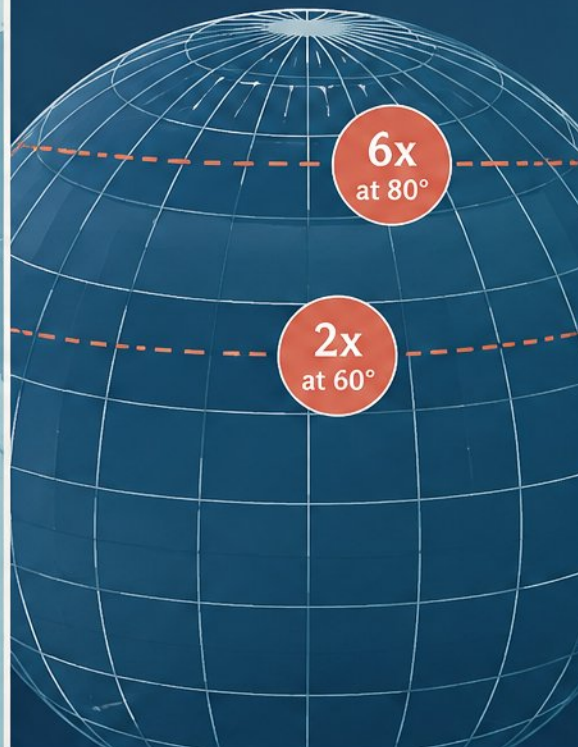
Greenland vs. Africa

On Mercator, Greenland looks as big as Africa
— Africa is 14x larger



Scale Factor with Latitude

Scale factor $1/\cos(\text{latitude})$:
about 2x at 60°, nearly 6x at 80°



Alaska vs. Australia

Alaska looks as large as Australia,
which truly is 4.5x bigger



Canada vs. Europe

Canada looks bigger than Europe,
but Europe's real area is slightly larger



Diagnose any map: check graticule,
indicatrix pattern, and known-area pairs



Try Equal Earth Lab or The True Size Of
to drag countries and compare

Global Shift in 2026: The UN Resolution and Equal Earth

MAPS SHAPE PERSPECTIVE. A MORE INCLUSIVE WORLD LOOKS FURTHER.



- Sept 4, 2026: UN adopts A/80/L.104, 164 votes to 1
- Non-binding: Mercator not banned, but expectations shift for education and media
- Equal Earth (2018, Šavrič, Patterson, Jenny) preserves area; Robinson-like look
- Framed as cognitive justice, boosting Africa's accurate visibility
- ICA counterpoint: no projection is best for all purposes
- Togo updating textbooks; Mapbox and QGIS now support Equal Earth

A
WIDER
WORLD
A BRIGHTER
TOMORROW

Why It Matters: Media, Navigation, and Education



Mercator's inflated Europe and North America subtly shape perceptions of global power



Web Mercator (EPSG:3857) dominates Google Maps, OpenStreetMap, and Mapbox for square, aligned tiles



Navigation still needs Mercator's conformal angles—this says nothing about fair area comparison



Students build a mental world map from one default, rarely knowing it was a choice



News outlets and journals are increasingly expected to declare their projection



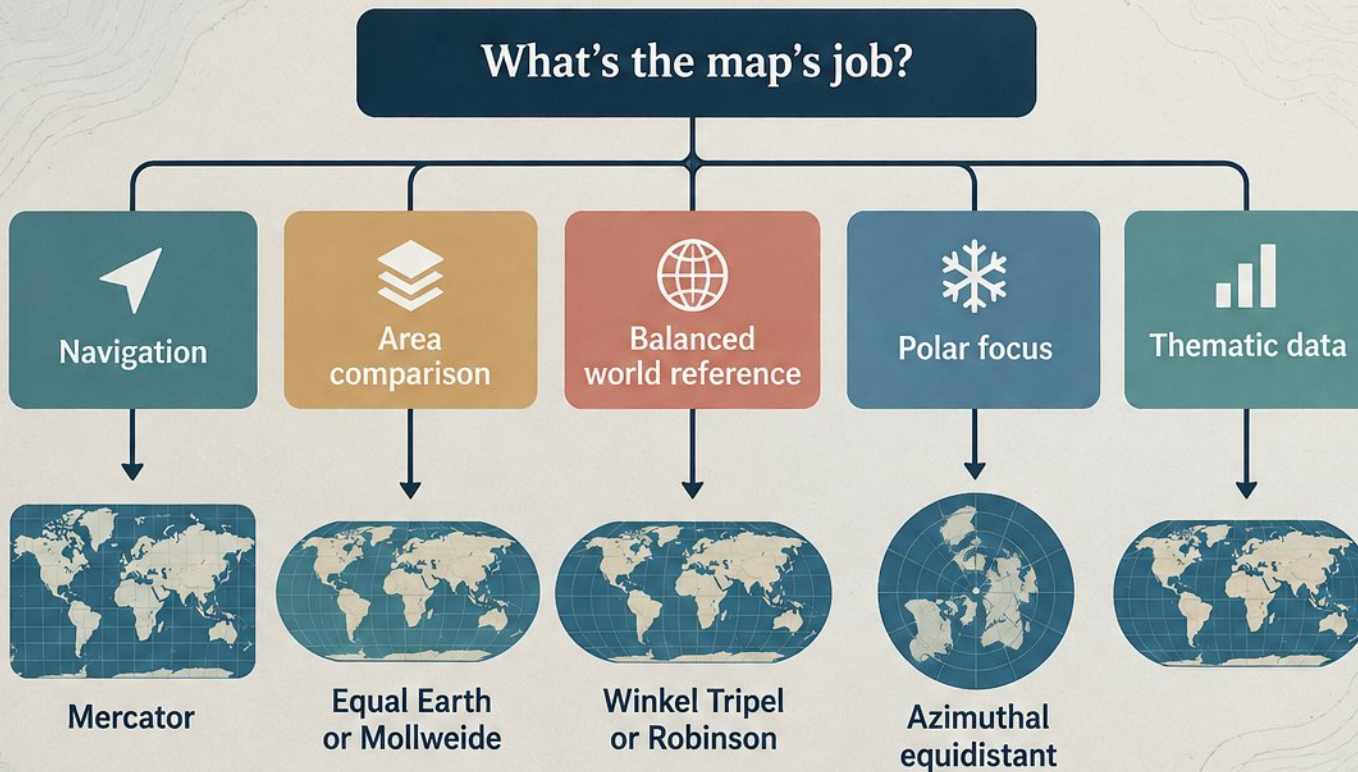
Ethics and Responsibility in Map Design

- Every map shapes perception; ethical mapmaking means deliberate, justifiable choices
- Know your audience; never intentionally mislead; show all relevant data
- Don't let software defaults drive your design
- Locus Charter and BCS code: honesty, integrity, competence, respect, responsibility
- Bias can be inherited, not just intentional—Web Mercator perpetuates distortion quietly
- State your projection in captions and metadata; 44% of geoscience maps don't



Hands-On: Choosing the Right Projection for the Job

SAME WORLD
DIFFERENT PERSPECTIVES
BRIGHTER INSIGHTS



- Match projection to purpose:
navigation → Mercator;
area → Equal Earth or Mollweide
- Balanced world reference →
Winkel Tripel or Robinson;
polar focus → azimuthal equidistant
- Compare projections side by side
on map-projections.net;
morph Mercator ← Equal Earth in D3
- Activity: compare one dataset
across three projections; note which
patterns appear
- Critique a news or textbook map:
what projection, what's distorted,
does it serve the story?
- Pitfalls: Web Mercator for area
comparisons; missing projection
notes; confusing equal-area with
equal-shape

Same world, different projections



Mercator



Robinson



Equal Earth



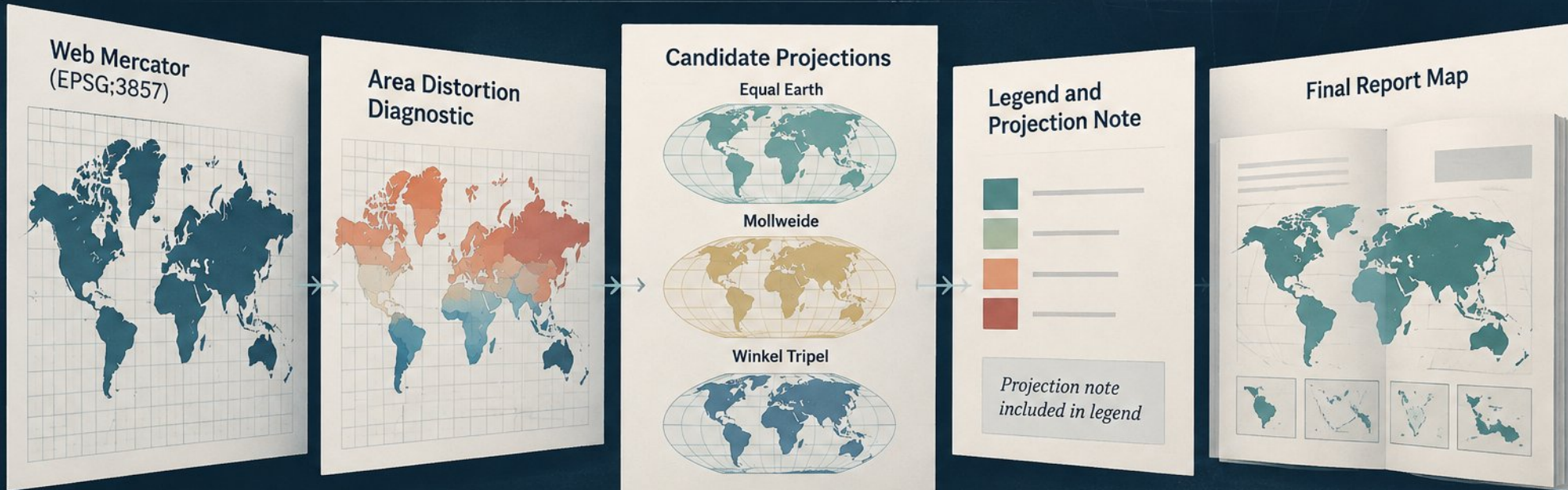
MAPS
SHAPE
PERSPECTIVE



Case Study: Redesigning a Global Data Map

MAPS FOR A HEALTHIER, MORE EQUITABLE WORLD

PEOPLE
PLACES
PERSPECTIVE
PROGRESS



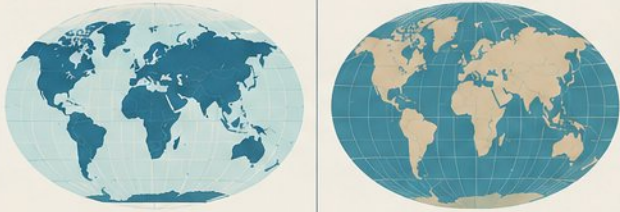
- 1 **Scenario:** design team maps global health access for an annual report
- 2 **Step 1:** purpose is comparing country rates by area — choose equal-area
- 3 **Step 2:** diagnose Web Mercator (EPSG:3857) area distortion as baseline
- 3 **Step 3:** test Equal Earth, Mollweide, and Winkel Tripel against the message
- 4 **Step 4:** document the choice, add a projection note in the legend
- 5 **Step 5:** check color, labels, and inset panels for small nations

BETTER MAPS
BRIGHTER
HEALTHIER
COMMUNITIES

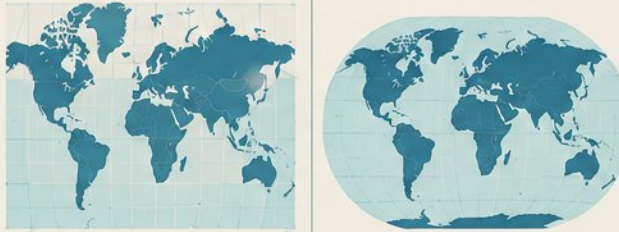
Common Misconceptions and How to Address Them

MAPS
INFORM
A BRIGHTER
PERSPECTIVE

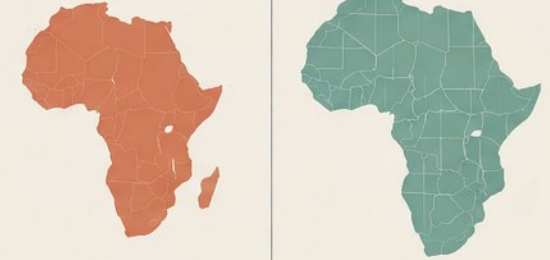
Myth: one correct world map exists — every flat map distorts



Myth: Mercator is simply wrong — it is right for navigation, wrong as a default



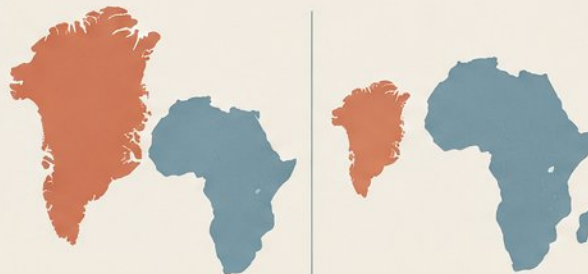
Myth: equal-area maps are fully accurate — they still distort shape



Myth: web maps use GPS, so they are accurate — zooming reduces, never removes, distortion



Myth: the 'Mercator effect' is proven — recent perception studies do not confirm it



Strategy: pair each myth with a counter-example students verify in an interactive tool



DIFFERENT MAPS.
A RICHER UNDERSTANDING.

PEOPLE PLACES PERSPECTIVES

Key Takeaways and Further Exploration

MAPS INFORM A BRIGHTER, MORE NUANCED VIEW OF OUR WORLD



All flat maps distort by mathematical necessity; informed choices reduce misleading impressions



Four distortion types: area, shape, distance, direction



Mercator (navigation), Gall-Peters (area), Robinson and Winkel Tripel (compromise), Equal Earth (area)



Reflection: "I would use an equal-area map when..., but another representation when..."



Try Equal Earth Lab, map-projections.net, The True Size Of, and ICA factsheets



Ask always: what is this map distorting, and why?

SAME WORLD
DIFFERENT VIEWS



DIFFERENT
PROJECTIONS
A RICHER WORLD

Reflection

"I would use an equal-area map when..., but another representation when..."

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