

Geography 12: Maps and Spatial Reasoning
Lecture 2: The Scale Transformation

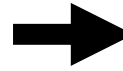
Professor Keith Clarke



Today's Theme: transformations



World or section of the world



Map: collections of symbols

My symbolic representation of a transformation



From earth to map

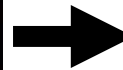
- Start: Earth or part of the earth
- Next: Scale transformation
- Next: Projection transformation
- Next: Symbolization and representation
- Last: Reading and interpretation
- End: Mental "image" of earth or part of earth



The scale transformation



The real world



1:400M



A representation of the world

Small scale and large scale

- In many fields, biology and ecology for example, “scale” is used as a more general term than in cartography
- Large scale = global, extensive
- Small scale = detailed, localized
- Usage is opposite in cartography
- My solution is never to say “scale”
- Use “map scale” or “cartographic scale”
- Use detailed or extensive scale
- Scale gives us a sense of how big

Map Scale

- *Map scale* is based on the representative fraction, the ratio of a distance on the map to the same distance on the ground
- Most maps fall between 1:1 million and 1:1000
- Digital and web maps are *scale-less* because maps can be enlarged and reduced and plotted at many scales other than that of the original data
- But in fact, all maps when displayed have a scale

Non-scientific Quiz #3

- If a globe is one meter around (circumference), what is its approximate scale?
- a. One inch to five feet
 - b. 1:250 000
 - c. 1:24 000
 - d. 1: 1 million
 - e. 1:40 million

Non-scientific Quiz #3

- If a globe is one meter around (circumference), what is its scale?
- One meter on the map corresponds to 40 million meters on the ground
- $RF = \text{map distance} / \text{ground distance}$
- $RF = 1 \text{ meter} / 40\,000\,000 \text{ meter}$
- Globe scale is 1 to 40 million
- Or 1:40 million or 1/40 million

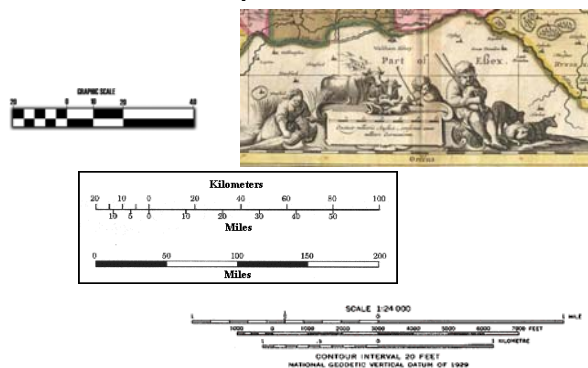
Earth 1:1M



Three ways of communicating scale

- The RF
 - As a ratio e.g. 1:200,000
 - As a fraction e.g. $1/200,000$
 - Often abbreviated e.g. 1:24K
 - Beware of periods and commas
- Equivalent lengths
 - E.g. Inch to a mile
 - E.g. One inch to 2000 feet
- As a graphic

Graphic scale



Advantages of a graphic scale

- Can be used for direct measurements on the map
- Is true at whatever enlargement or reduction you use on the map
- Can show different units, e.g. miles and kilometers
- BUT cannot account for scale differences on the map
- May be directionally biased

But.....



Universal plotting chart
Linear distance is a function of
Latitude! Means distances N-S
Different from E-W and diagonals



A word on units



- English units standardized for mapping and surveying
- Inch-foot-yard-rod-chain-furlong-mile
- 12-3-16.5ft-66ft-10-8
- A mile is 5280 ft
- International Nautical mile
= 6076.11549 ft = 1852 m
- Nautical mile (6080 ft.) =
- one minute of arc of a great circle



The “mile high” city



Remember Datums?

- Three markers on the steps of the Colorado State Capitol that identify this point.
- The first marker was installed in 1909 on the fifteenth step, but was stolen several times before a more permanent "ONE MILE ABOVE SEA LEVEL" marker was engraved in 1947.
- The second marker was placed in 1969 by Colorado State University engineering students on the eighteenth step, after resurveying the elevation.
- Third marker was placed in 2003, after surveyors using the new national vertical datum, determined that the thirteenth step was exactly at one-mile above sea level.



A note on areas

- 144 square inches = one square foot
- Note 10 square feet is not ten feet square
- 9 sq. ft. = 1 square yard
- 160 square rods = 10 sq. chains = 1 acre
- 640 acres = one square mile
- Baseball diamond around the bases = 90 feet square = 8100 sq. ft. = 752.49 square meters



Fortunately, we have the metric system

- 1000 mm = 1m
- 1000 m = 1 km
- 1000 mm x 1000 mm = 1 square meter (metre)
- 10 000 square meters = 1 hectare
- NOTE: 10 square meters is NOT 10 meters squared

The mantra

The representative fraction is the map distance divided by the ground distance in the same units



Burn in!

The representative fraction is the map distance divided by the ground distance in the same units

The formula

$$RF = MD / GD$$

Only issue: different units feet, yards, miles;
mm, m, km

Calculating scale from a map



Known distances, calculate scale

- Bridge to cemetery on map = 126 mm
- Bridge to cemetery on the ground = 3024m
- $RF = MD / GD = 126 / 3024000$
- $RF = 1 : 24\ 000$

Scale of a baseball earth



- Baseball circumference = 226 mm
- Earth circumference approx 40 million meters
- RF is : 1:177 million

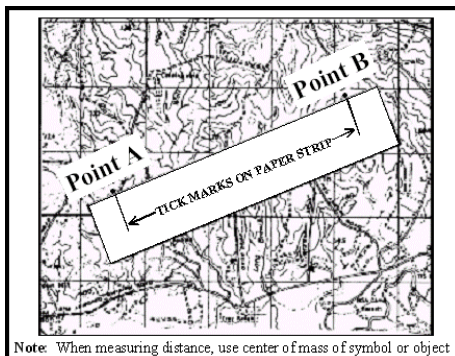
Calculating ground distance from a map



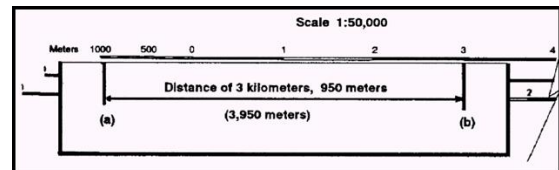
Known scale, calculate distances

- Map distance = 300mm
- Map scale = 1:50 000
- $RF = MD / GD$ so $GD = MD / RF$
- 1/RF is the denominator
- $GD = 300 \text{ mm} \times 50\,000 = 15\,000\text{m}$

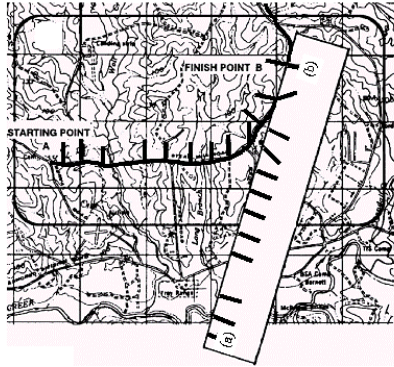
The paper strip-to-graphic scale trick



Move the paper to the graphic scale Read off distance



Trick works along roads



Examples

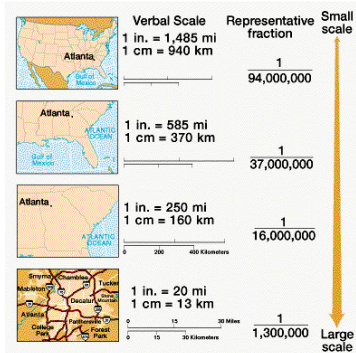


Figure 4a
Scale 1:24000
1 inch = 2000feet
Area Shown: 1 square
mile

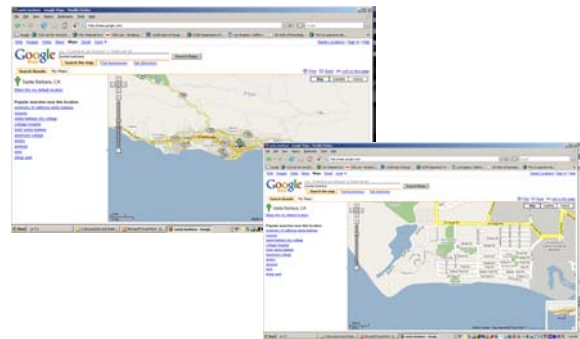
Figure 4b
Scale 1:62500
1 inch = nearly 1 mile
Area Shown: 6 3/4
square miles

Figure 4c
Scale 1:250,000
1 inch = nearly 4 miles
Area Shown: 107 square
miles

Bigger range



Zoom: New features at new scale



Some common map scales

Round numbers makes life easier

- 1:24 000
- 1:50 000
- 1:100 000
- 1:62 500
- 1:63 360
- 1:250 000
- 1:500 000
- 1: 1M

The take-home

- The map scale transformation is the first, and changes data about the earth into a representation at a particular scale
- Don't use the terms large and small scale
- Most maps are between 1:1000 and 1:400M
- $RF = MD / GD$
- The paper strip trick works
- Most maps are at standard scales, like 1:50 000
- Computer-based maps can be zoomed