

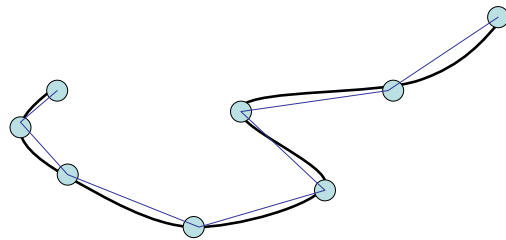
Geography 12: Maps and Spatial Reasoning

Lecture 9: Cartometry: Lines and Areas

Professor Keith Clarke



A generic line



$(X_1, Y_1) \dots (X_n, Y_n)$

Line and Area features on topo maps

BOUNDARIES	
National	-----
State or territorial	-----
County or equivalent	-----
Civil township or equivalent	-----
Incorporated city or equivalent	-----
Federally administered park, reservation, or monument (external)	=====
Federally administered park, reservation, or monument (internal)	=====
State forest, park, reservation, or monument and large county park	-----
Forest Service administrative area*	-----
Forest Service ranger district*	-----
National Forest System land status, Forest Service lands*	=====
National Forest System land status, non-Forest Service lands*	-----
Small park (county or city)	-----

Roads as lines



Land surveys and roads

LAND SURVEYS		ROADS AND RELATED FEATURES	
<i>Public land survey system</i>			
Range or Township line		Please note: Roads on Provisional-edition maps are not classified as primary, secondary, or light duty. These roads are all classified as improved roads and are symbolized the same as light-duty roads.	
Location approximate		Primary highway	
Location definite		Secondary highway	
Protracted		Light duty road	
Protracted (AK 1:62,500 scale)		Light duty road, paved*	
Range or Township labels		Light duty road, gravel*	
Section line		Light duty road, dirt*	
Location approximate		Light duty road, unspecified*	
Location definite		Unimproved road	
Protracted		Unimproved road*	
Protracted (AK 1:62,500 scale)		4WD road	
Section numbers		4WD road*	
Found section corner		Trail	
Found closing corner		Highway or road with median strip	
Witness corner		Highway or road under construction	
Meander corner		Highway or road underpass, overpass	
Weak corner*		Highway or road bridge, drawbridge	
<i>Other land surveys</i>			
Range or Township line		Highway or road tunnel	
Section line		Road block, berm, or barrier*	
Land grant, mining claim, donation land claim, or tract		Gate on road*	
Land grant, homestead, mineral, or other special survey monument		Trailhead*	
Fence or field lines			

A "length" datum

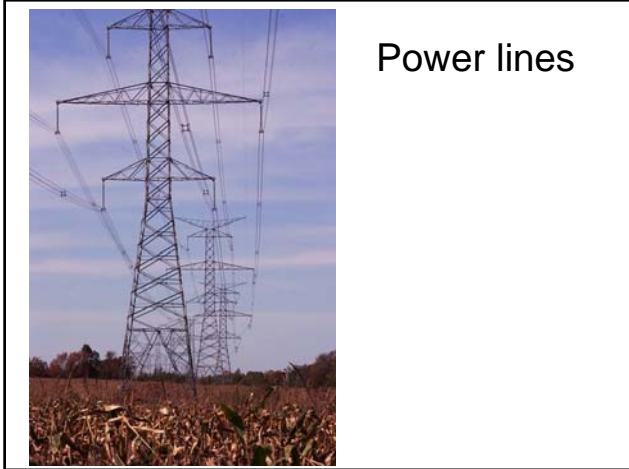


Railroads



Railroads

RAILROADS AND RELATED FEATURES	
Standard gauge railroad, single track	
Standard gauge railroad, multiple track	
Narrow gauge railroad, single track	
Narrow gauge railroad, multiple track	
Railroad siding	
Railroad in highway	
Railroad in road	
Railroad in light duty road*	
Railroad underpass; overpass	
Railroad bridge; drawbridge	
Railroad tunnel	
Railroad yard	
Railroad turntable; roundhouse	

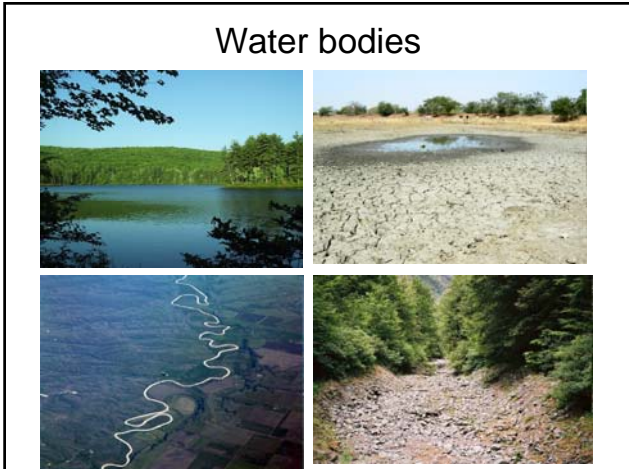


Power lines

Lines and areas

TRANSMISSION LINES AND PIPELINES	
Power transmission line; pole; tower	
Telephone line	
Aboveground pipeline	
Underground pipeline	

VEGETATION	
Woodland	
Shrubland	
Orchard	
Vineyard	
Mangrove	



Watery symbols

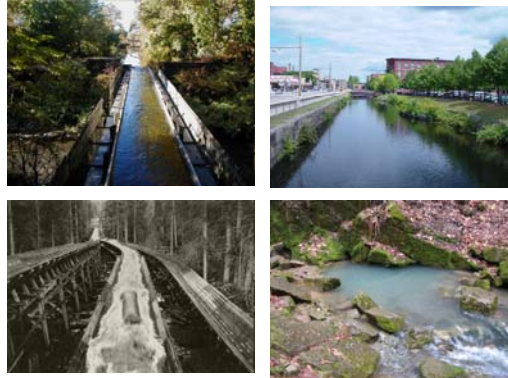
MARINE SHORELINES	RIVERS, LAKES, AND CANALS
Shoreline	Perennial stream
Apparent ledge of vegetation***	Perennial river
Indefinite or unsurveyed	Intermittent stream
	Intermittent river
	Disappearing stream
	Falls, small
	Falls, large
	Rapids, small
	Rapids, large
	Massive dam
	Dam with lock
	Dam carrying road

COASTAL FEATURES	
Foreshore flat	
Coral or rock reef	
Rock, bare or awash; dangerous to navigation	
Group of rocks, bare or awash	
Exposed wreck	
Depth curve; sounding	
Breakwater, pier, jetty, or wharf	
Seawall	
Oil or gas well; platform	

Water features



Aqueduct/Canal/Flume/Spring



More water

RIVERS, LAKES, AND CANALS – continued

Perennial lake/pond	
Intermittent lake/pond	
Dry lake/pond	
Narrow wash	
Wide wash	
Canal, flume, or aqueduct with lock	
Elevated aqueduct, flume, or conduit	
Aqueduct tunnel	
Water well, geyser, fumarole, or mud pot	
Spring or seep	

Ice and snow

GLACIERS AND PERMANENT SNOWFIELDS

Contours and limits	
Formlines	
Glacial advance	
Glacial retreat	



Surface features: Strip mine



Swamps



Surface features

SUBMERGED AREAS AND BOGS	
Marsh or swamp	
Submerged marsh or swamp	
Wooded marsh or swamp	
Submerged wooded marsh or swamp	
Land subject to inundation	
SURFACE FEATURES	
Levee	
Sand or mud	
Disturbed surface	
Gravel beach or glacial moraine	
Tailings pond	

Topography



Contours: Whole separate lecture

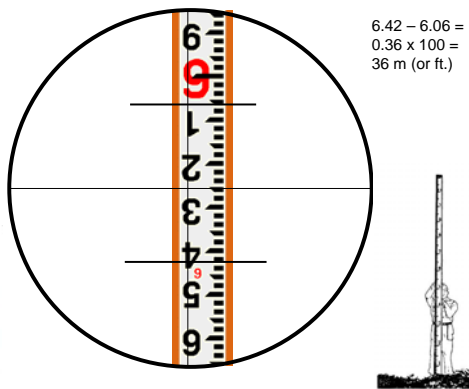
CONTOURS	
<i>Topographic</i>	
Index	
Approximate or indefinite	
Intermediate	
Approximate or indefinite	
Supplementary	
Depression	
Cut	
Fill	
Continental divide	
<i>Bathymetric</i>	
Index***	
Intermediate***	
Index primary***	
Primary***	
Supplementary***	

Distance measurement: from the ground

- Pacing
- Survey
 - Chain/Pole
 - Wheel
 - Stadia
 - EDM
 - GPS
- Tape
- Triangulation
- Ships log



Distance with Stadia



Distance on the ground

- Odometer
- GPS point trace
- Dead reckoning
- Record coordinates and compute

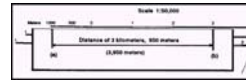


Pacing

- Measure a base line using a superior method
- Devise method for pace counting
- Repeat measurement several times
- Average result and divide for length of pace
- Note how pace varies with terrain



Measuring on the map

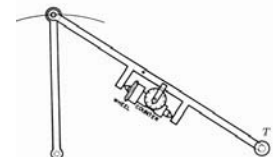
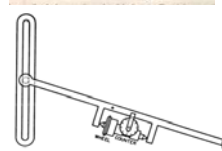
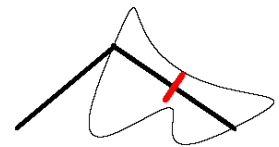
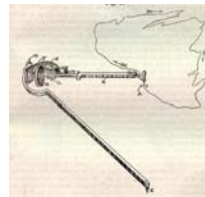


Length from coordinates

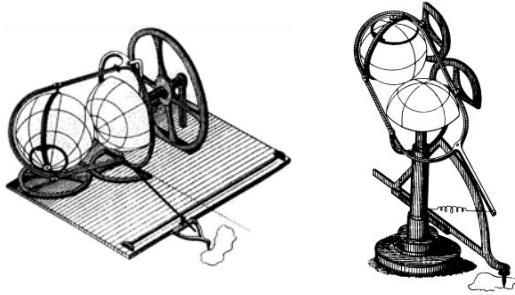
$$\text{length} = \sum_{i=1}^{npts} \sqrt{(x_i - x_{i-1})^2 + (y_i - y_{i-1})^2}$$



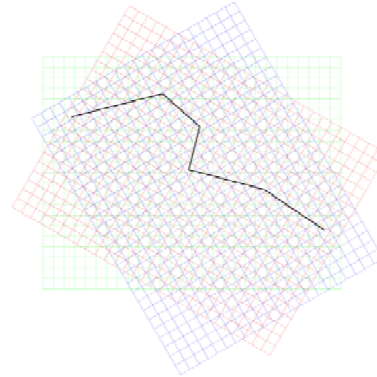
Area measurement: From the map Polar planimeter



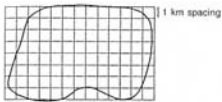
James Clerk Maxwell (1855)



Steinhaus Longimeter



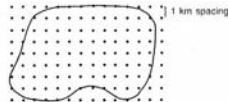
Four methods for area



$$\text{Area} = \{(\text{full cells}) + 1/2 (\text{partial cells})\} \times \text{cell value}$$

$$= [71 + 1/2(20)] \times 1 \text{ km}^2 = 84 \text{ km}^2$$

FIGURE 5.9 Grid-square method of areal measurement.



$$\text{Area} = [\text{dots within} + 1/2 (\text{dots on boundary})] \times \text{dot value}$$

$$= [75 + 1/2 (10)] \times 1 \text{ km}^2 = 84 \text{ km}^2$$

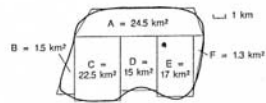
FIGURE 5.10 Dot-planimeter method of areal measurement.



$$\text{Area} = \text{total length of strips} \times \text{width}$$

$$= 84.2 \text{ km} \times 1 \text{ km} = 84.2 \text{ km}^2$$

FIGURE 5.11 Strip method of areal measurement.

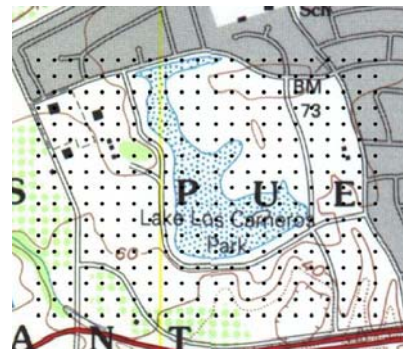


$$\text{Total area} = \text{Areas (A} + \text{B} + \text{C} + \text{D} + \text{E} + \text{F)}$$

$$= 81.8 \text{ km}^2$$

FIGURE 5.12 Polygon method of areal measurement.

For example, Lake Los Carneros

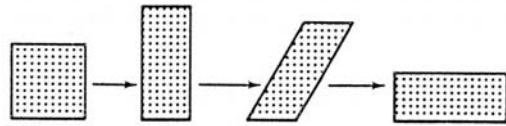


Area from coordinates

$$A = \frac{1}{2} \left| \sum_{i=1}^{npts+1} (x_i y_{i-1}) - (x_{i-1} y_i) \right|$$

Equivalence

FIGURE 198. Equal-area diagram.



Summary

- Topo maps and others show line and area features
- Features have different symbols and colors
- We can measure length and bearing of lines
- We can measure area of areas
- We can do this from the map or the coordinates