

Calculation of the Surface Area by Geographic Coordinates Exercise 02

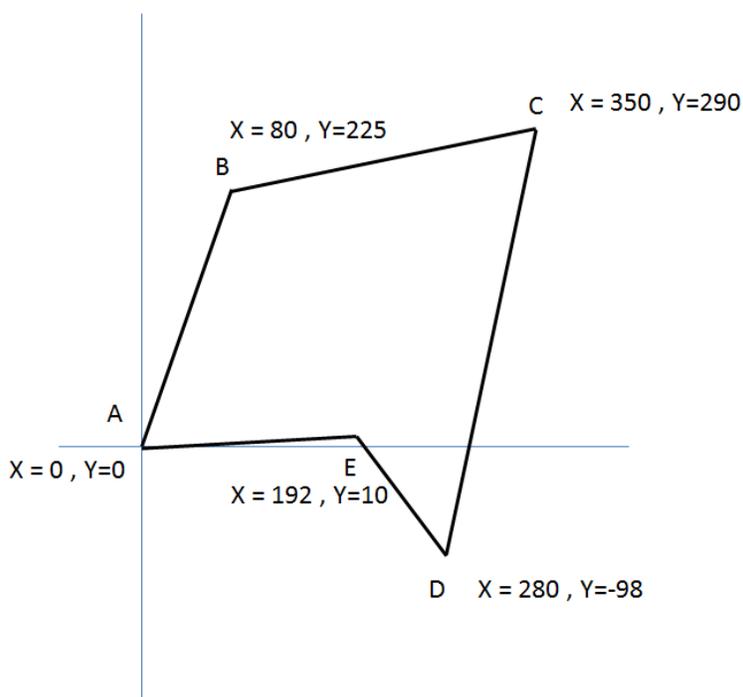
The Global Position (NAVSTAR) System that was discussed in Lesson 1 can be used for surveying the location and areas of pastures, forests, lakes, and rangelands. The estimate of surface areas is one of the more useful applications of this technology.

Determination of area from coordinates is a simple process for a closed polygon with known coordinates for each corner. The area is equal to 1/2 the sum of the products obtained by multiplying each Y-coordinate by the difference between the adjacent X-coordinates. The X-coordinates must always be taken in a sequential order around the polygon we typically go clockwise. This rule can also be stated as follows: The area is equal to 1/2 the sum of the products obtained by multiplying each X-coordinate by the difference between the adjacent Y-coordinates, taken in the same order around the figure.

For the pasture below, the rule is applied in the following relation:

$$\text{Area} = \frac{1}{2} [X_A(Y_E - Y_B) + X_B(Y_A - Y_C) + X_C(Y_B - Y_D) + X_D(Y_C - Y_E) + X_E(Y_D - Y_A)]$$

This formula is based on the summation of the areas of a series of trapezoids and can be derived from coordinate geometry.



Solution

Calculation of Area from Coordinate Pairs

Point	X	Y	Double Area	
A	0	0	0	$= X_A(Y_E - Y_B)$
B	80	225	-23,200	$= X_B(Y_A - Y_C)$
C	350	290	113,050	$= X_C(Y_B - Y_D)$
D	280	-98	78,400	$= X_D(Y_C - Y_E)$
E	192	10	-18,816	$= X_E(Y_D - Y_A)$
A	0	0		
			149434	= Double Area (m ²)
Area =	74,717	m ²	7.4717	ha

This problem can either be done by hand or you can build a spreadsheet to solve it. We suggest building a spreadsheet template that can be modified depending on the number of locations that are taken during the circuit. A template is a spreadsheet form or model that can be easily modified to solve similar problems that consist of the same types of data.

Of course, if you import the positions into a Geographic Information System (GIS) software package, the GIS will automatically calculate the perimeter and surface area of the polygon even if the positions are in the geographic (latitude/longitude) projection.

Problems

1. You have obtained the following pairs of coordinates by GPS as you traversed around a location near Nimbol, India. You are using UTM coordinate system Zone 43 (72° E to 78° E, Northern Hemisphere) with a WGS84 datum and all measurements are in meters. What is the area of this Field?

Point	Easting	Northing	Elevation
A	384420.7	2908829	278
B	384611.6	2908817	275
C	384621.6	2908759	276
D	384621.6	2908705	279
E	384418.9	2908723	280
F	384418.9	2908723	280
A	384420.7	2908829	278

2. You have obtained the following pairs of coordinates by GPS as you traversed around a pasture on In India. You are using UTM coordinate system Zone 43 (72° E to 78° E, Northern Hemisphere) with a WGS1984 datum and all measurements are in meters. What is the area of this pasture?

Point	Easting	Northing	Elevation
A	384605	2908853	274
B	384750	2908881	279
C	384773	2908877	279
D	384830	2908883	279
E	384845	2908766	278
F	384853	2908759	278
G	384924	2908772	280
H	384990	2908775	281
I	385025	2908781	281
J	385042	2908710	281
K	384970	2908685	281
L	384982	2908638	280
M	384910	2908611	280
N	384904	2908644	280
O	384830	2908632	282
P	384757	2908595	286
Q	384735	2908585	286
R	384679	2908569	285
S	384646	2908565	284
T	384624	2908706	279

A	384605	2908853	274
---	--------	---------	-----

3. You have obtained the following pairs of coordinates by GPS as you traversed around a pasture near Nimbol, India. You are using UTM coordinate system Zone 43 (72° E to 78° E, Northern Hemisphere) with a WGS1984 datum and all measurements are in meters. What is the area of this pasture?

Point	Easting	Northing	Elevation
A	384270.9	2907827	274.271
B	384279.2	2907902	274.792
C	384296	2907979	274.703
D	384342.8	2907981	272.392
E	384377.9	2907988	269.909
F	384406.4	2907911	268.509
G	384408	2907877	268.414
H	384421.4	2907850	267.953
I	384439.8	2907825	268.305
J	384458.2	2907802	269.327
K	384521.8	2907752	273.569
L	384495	2907628	277.773
M	384424.8	2907640	274.982
N	384424.8	2907640	274.982
A	384270.9	2907827	274.271