Affine Transformation

Katie Urey

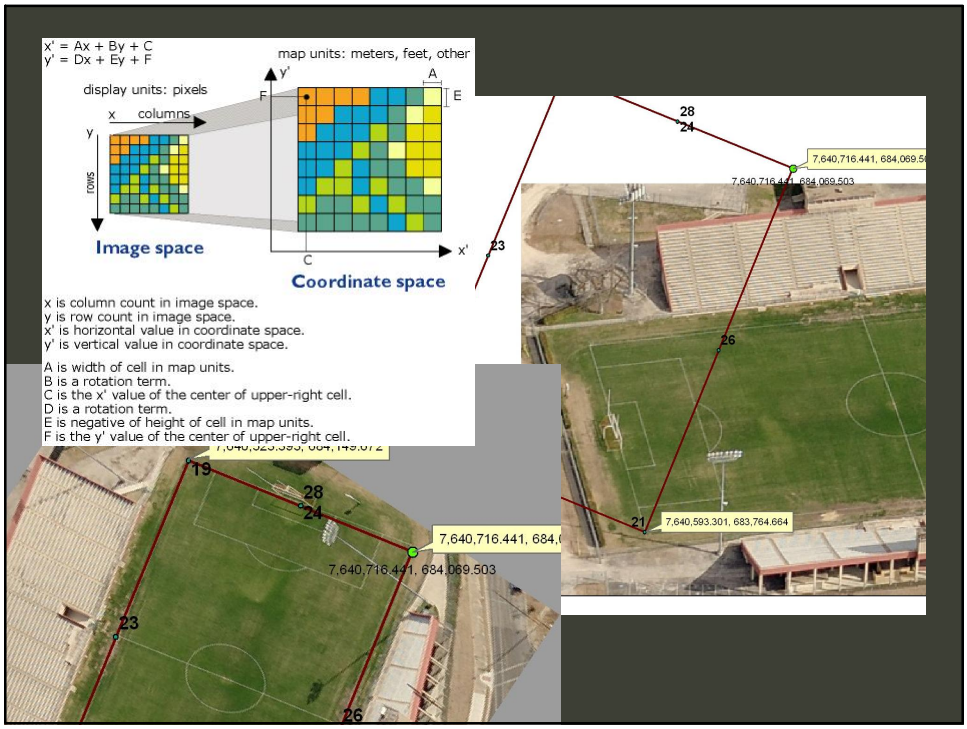
Compromises in Spatial Adjustments

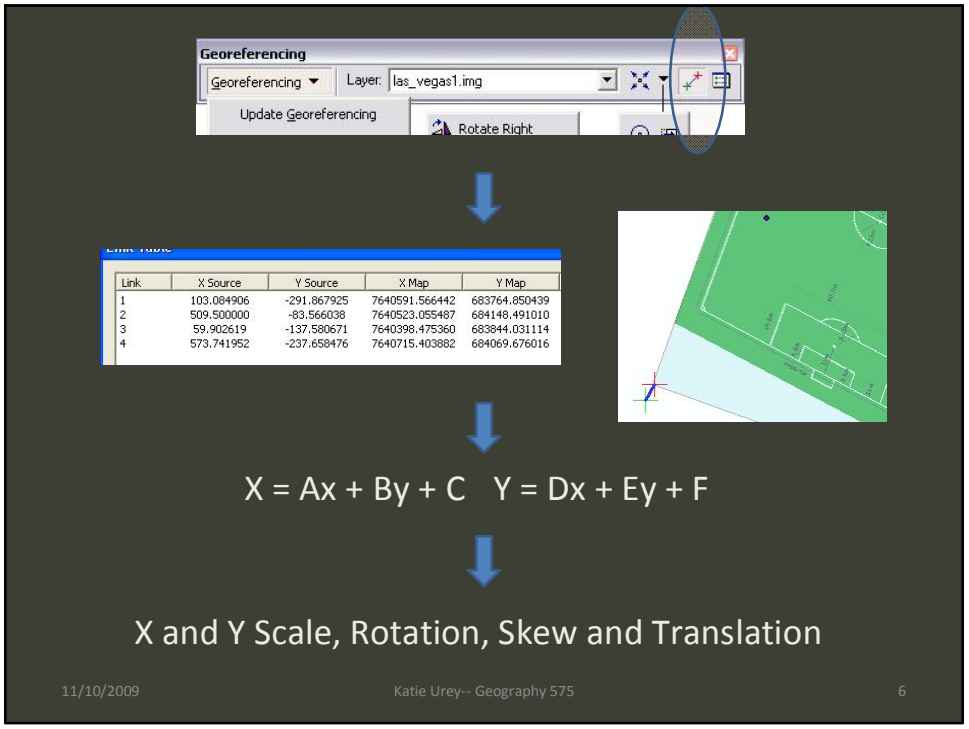
What Adjusts What Changes

Affine	Rotate Scale Skew Translate	Parallelism maintained	
Similarity	Rotate Scale Translate	Shape maintained	
Projective		Used with aerial photography (warping)	

Spatial Adjustment Problem

- Setup a mathematical model that will calculate a new location for each cell or coordinate.
- Keep edges parallel. Allow objects to rescale, translate, and rotate.
- The model exists and requires 6 coefficients.
- Discover the coefficients from a link table of pairs of control points.




Georeferencing
Georeferencing
Layer: las_vegas1.img
Update Georeferencing
Rotate Right
Link | X Source | Y Source | X Map | Y Map
1 | 103.084906 | -291.867925 | 7640591.566442 | 683764.850439
2 | 509.500000 | -83.566038 | 7640523.055487 | 684148.491010
3 | 59.902619 | -137.580671 | 7640398.475360 | 683844.031114
4 | 573.741952 | -237.658476 | 7640715.403882 | 684069.676016
X = Ax + By + C Y = Dx + Ey + F
X and Y Scale, Rotation, Skew and Translation
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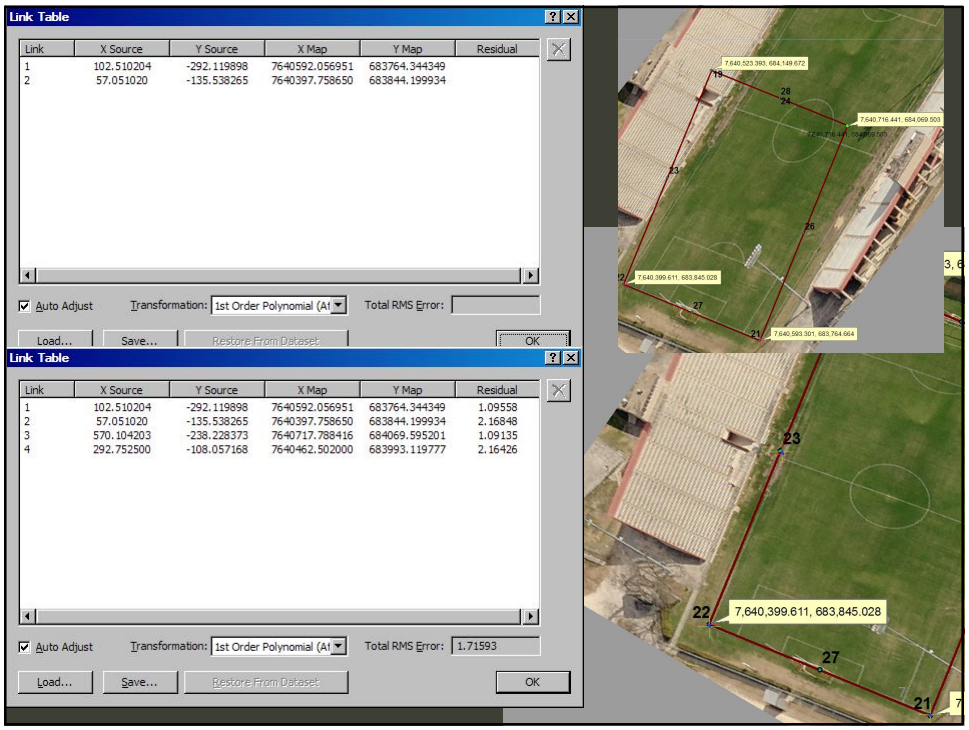

Link Table
Link | X Source | Y Source | X Map | Y Map | Residual
1 | 102.510204 | -292.119898 | 7640592.056951 | 683764.344349
2 | 57.051020 | -135.538265 | 7640397.758650 | 683844.199934
Auto Adjust
Transformation: 1st Order Polynomial (A
Total RMS Error:
Load...
Save...
Restore From Dataset
OK
Link Table
Link | X Source | Y Source | X Map | Y Map | Residual
1 | 102.510204 | -292.119898 | 7640592.056951 | 683764.344349 | 1.09558
2 | 57.051020 | -135.538265 | 7640397.758650 | 683844.199934 | 2.16848
3 | 570.104203 | -238.228373 | 7640717.788416 | 684069.595201 | 1.09135
4 | 292.752500 | -108.057168 | 7640462.502000 | 683993.119777 | 2.16426
Auto Adjust
Transformation: 1st Order Polynomial (A
Total RMS Error: 1.71593
Load...
Save...
Restore From Dataset
OK
7,640,399.611, 683,845.028
22
23
27
21

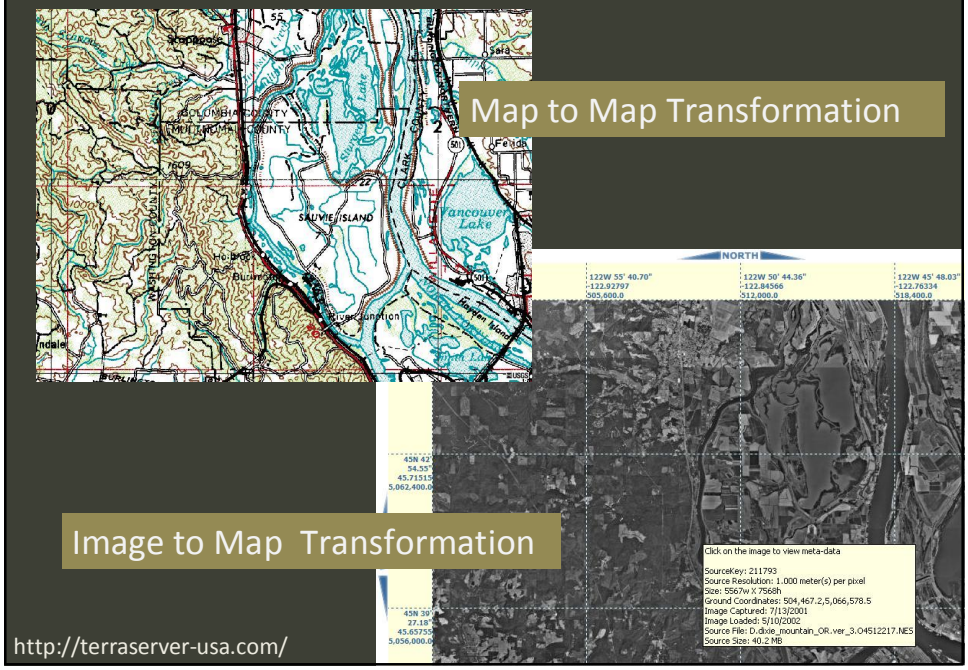
Root Mean Square – Is the estimated location good enough.

Chang's recommendations

- The producers sets the RMS tolerance.
- Scale and Accuracy of input are factors
- Less than 6 meters for a 1:24,000 map
- Less than 1 pixel for a 30 meter raster

Root Mean Square Error

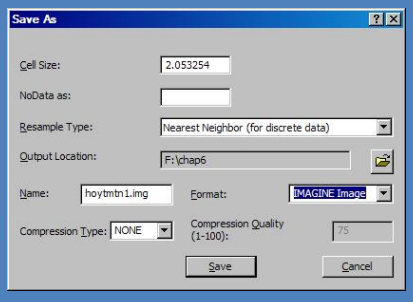
- RMS Error needs to stay within expected tolerance.
- Errors in longitude and latitude on source maps may propagate through to errors in new maps.
- Tic marks may be inaccurate.
- Low RMS errors do not guarantee a good transform.



	Map to Map	Image to Map
x and y	Vector coordinates	Raster rows and columns
Y equation	Y = Dx + Ey + F	Y = Dx - Ey + F
Selection of Control Points/ Ground Control Points	Use known values. Or project lat long to	Landmarks, best if captured by a single pixel, or adjusted to known coordinates from GPS/Maps
Number of Control Points/ Ground Control Pts	3 to find Coefficients 4 or more additional to manage RMS error.	More than 4. Chang suggests ~20 for some images.
Additional Steps	None	Resample

There are two choices to save the transform. Either a new data set, or a world file with the transform coefficients.

Rectify (resample)



Save Transform in external "WORLD" files.

Value	Coefficient
20	A
50	B
0	C
0	D
-15	E
30	F

References

ArcGIS Desktop Help 9.3, An overview of spatial adjustment

FAQ: What unit is RMS reported in ArcMap georeferencing tools?

TerraServer-USA http://terraserver-usa.com/

Introduction to Geographic Information Systems,

Kang-tsung Chang