

zero. If a particular GCP has unusually high error values, that usually means a human error in entering the coordinate values. So you can delete that GCP and capture it again. You can also edit the coordinate values in the GCP Table by clicking the cell in either Dest X and Dest Y.

NB The control points captured have a direct relationship to the transformation algorithm that you will use. The minimum number of control points is 3. When capturing points make sure you capture points that are evenly spaced from the map layout.

- Click on the gear (wheel) icon to select the transformation settings.
NB This is the most important part of georeferencing. You should read about what each transformation algorithm does before selecting one to use.
- Activate the options from the transformation settings i.e Transformation type, resampling method, Target CRS, Compression
- Start the georeferencing by pressing the play button.

Check your results:

Once you have finished georeferencing export the raster and it should overlay the layers loaded in QGIS

Name	Expectation
Reference Layer	Vector from natural earth (roads and buildings)
Resampling method One one type can be specified at each given time	Nearest Neighbour or Linear or Cubic or Cubic Spline or Lanczos
Transformation type The choice of transformation type depends on the number of GCP and type of raster being georeferenced	Linear or Helmert or Polynomial 1 -3 or Thin Plate Spline and Projective
Target CRS The target CRS specified the output CRS assigned to the raster after completing the georeferencing	EPSG:4326
Compression	LZW or Packbits or Deflate

 **More about georeferencing and transformation algorithms**

Depending on how many ground control points you have captured, you may want to use different transformation algorithms. Choice of transformation algorithm is also dependent on the type and quality of input data and the amount of geometric distortion that you are willing to introduce to the final result.

Currently, the following Transformation types are available:

- The Linear algorithm is used to create a world file and is different from the other algorithms, as it does not actually transform the raster. This algorithm likely won't be sufficient if you are dealing with scanned material.
- The Helmert transformation performs simple scaling and rotation transformations.
- The Polynomial algorithms 1-3 are among the most widely used algorithms introduced to match source and destination ground control points. The most widely used polynomial algorithm is the second-order polynomial transformation, which allows some curvature. First-order polynomial transformation (affine) preserves collinearity and allows scaling, translation and rotation only.
- The Thin Plate Spline (TPS) algorithm is a more modern georeferencing method, which is able to introduce local deformations in the data. This algorithm is useful when very low-quality originals are being georeferenced.
- The Projective transformation is a linear rotation and translation of coordinates.

Check your knowledge:

1. Is it possible to georeference vector data:
 - a. True
 - b. False
2. What is the importance of having a low value for the residuals for the ground control points (GCP):
 - a. It ensures high accuracy for the selected point on the map and the captured coordinates
 - b. The effects are minimal when you use the map canvas to capture the coordinates of the ground control point
 - c. The residual do not have any effect on the final output
3. Which of the following methods for capturing ground control points ensures high accuracy for the final output:
 - a. Manually entering them as Decimal degrees or Degree minutes and seconds
 - b. Capturing them from the map canvas
 - c. Adding GCP points saved by someone
 - d. All of the above

Module video tutorial:

- <https://youtu.be/SMSxAxLiKN4>

Further reading:

- qgistutorials.com: http://www.qgistutorials.com/en/docs/advanced_georeferencing.html
- Transformation types detailed: https://docs.qgis.org/latest/en/docs/user_manual/working_with_raster/georeferencer.html#available-transformation-algorithms
- ordnancesurvey.co.uk: <https://www.ordnancesurvey.co.uk/support/understanding-gis/georeferencing.html>
- QGIS Training Manual: https://docs.qgis.org/latest/en/docs/training_manual/forestry/map_georeferencing.html

Download the sample data for the lesson from http://changelog.qgis.org/media/images/lesson/worksheet/external_data/d550c09d44c7128d4fad4a067ca35676d634ef01.zip.