
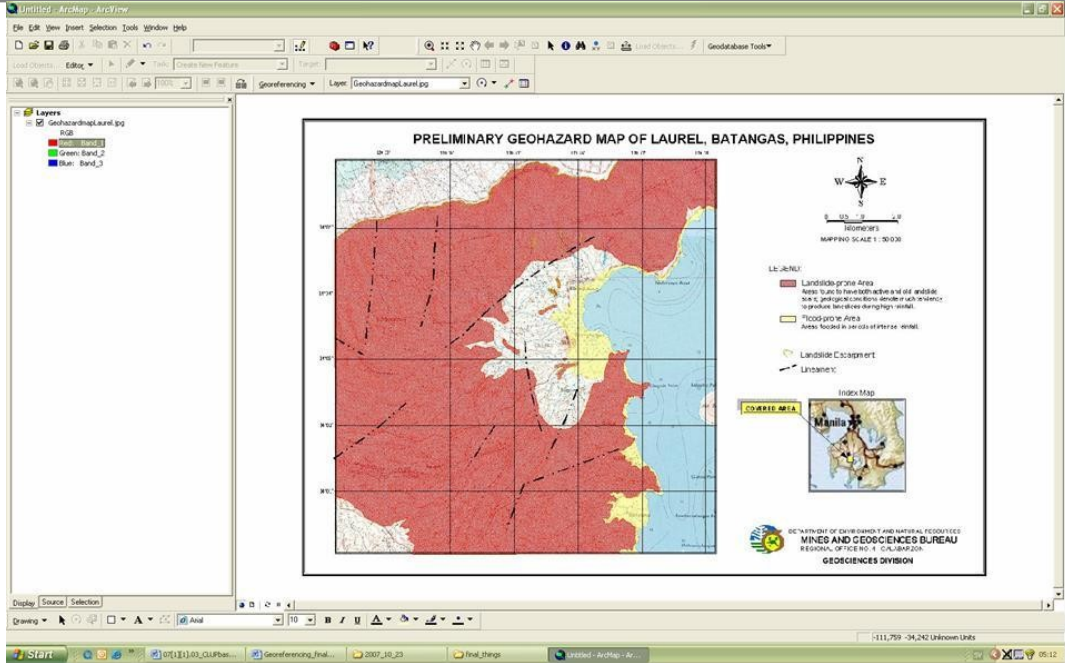
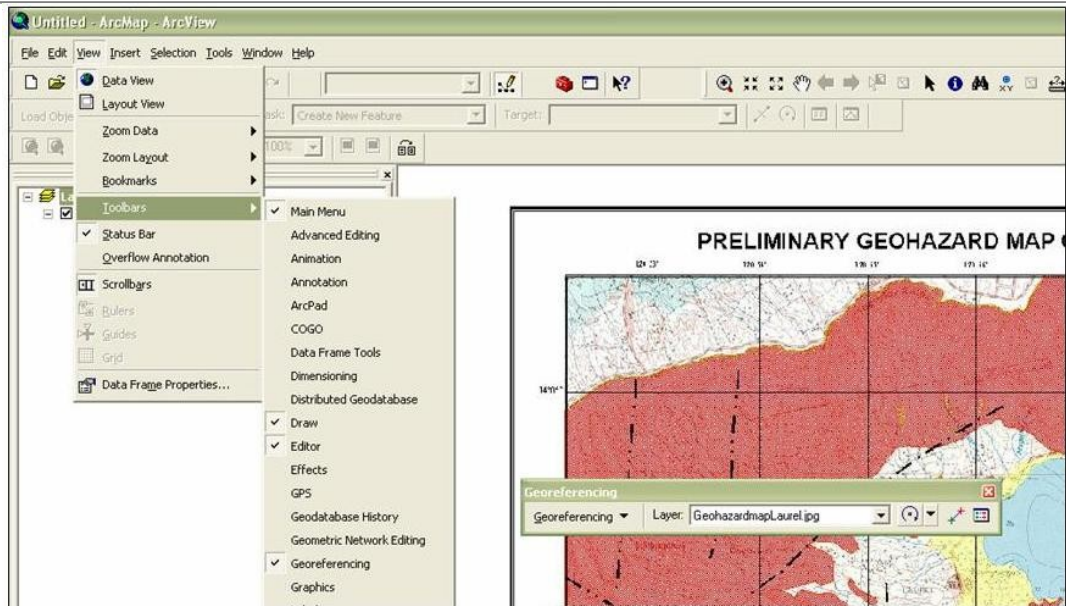




7.03.01 Georeferencing Tutorial

Introduction	
	<p><i>Georeferencing is the first step when making analogue data digital. After Georeferencing, digitizing procedures follow so that the features of the analogue map also will be digital.</i></p> <p><i>In this tutorial you will georeference an analogue Geohazard map over Laurel. Thus, the output of this tutorial is a georeferenced map that can be used for further digitizing. However, the objective of this tutorial is only to introduce you to the steps of Georeferencing. Therefore, the exercise won't include more than Georeferencing.</i></p>
Getting started	
1	Open ArcMap, select a new empty map. You will now save the map file. Select File > Save as... from the menu bar. Browse to the folder <i>C:\HLURB\CLUP\01_CLUPGIS (Laurel)\06_Workfolder\</i> and type 'Georeferencing_v1.mxd'. Click Save/OK .
2	Add the image file, <i>GeohazardmapLaurel.jpg</i> to ArcMap. . Click on the <i>add data</i> button  and browse to <i>C:\HLURB\CLUP\01_CLUPGIS (Laurel)\03_EM\</i> and select the file. Click OK . (The image is added to the workspace, see below.)
	
3	In the menu bar select View > Toolbar > Georeferencing to get the <i>Georeferencing</i> tool bar. The <i>Georeferencing</i> tool bar will appear on your screen. (See image below.) You can drag and drop the tool bar to a suitable place within

the ArcMap window.



Identification of control points

First thing is to identify the quality of possible control points (at least four). The best thing is if your source data contains a grid with coordinates. Then you should use grid intersections as control points. If the source data doesn't include a grid then you can choose road intersections, buildings and other obvious landmarks as control points. They have to be identifiable in other reference data (your digital datasets) because you will get the coordinates from this data.

In our image GeohazardmapLaurel.jpg we have a grid that we will use to select control points (see image below).

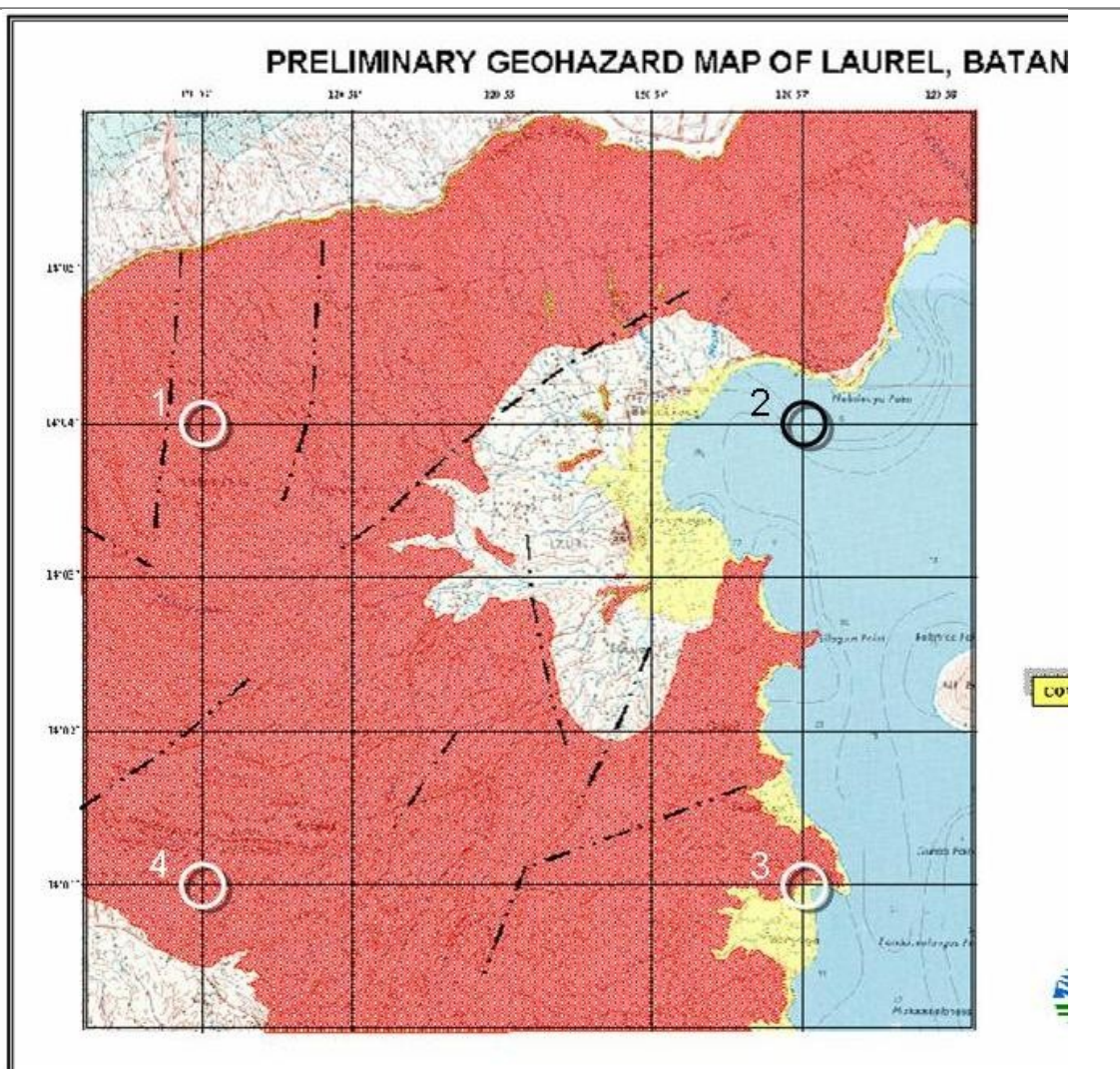
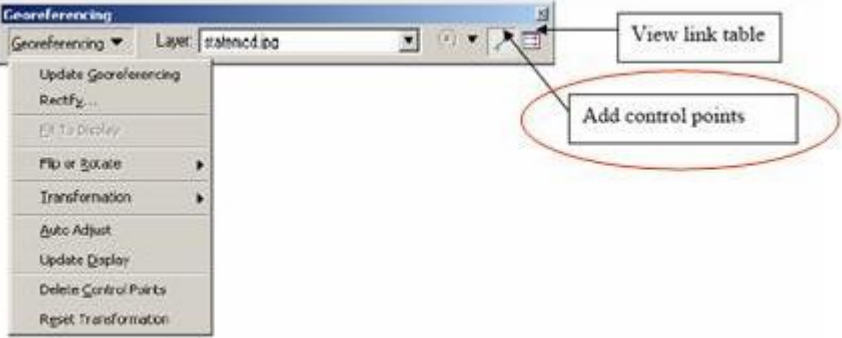
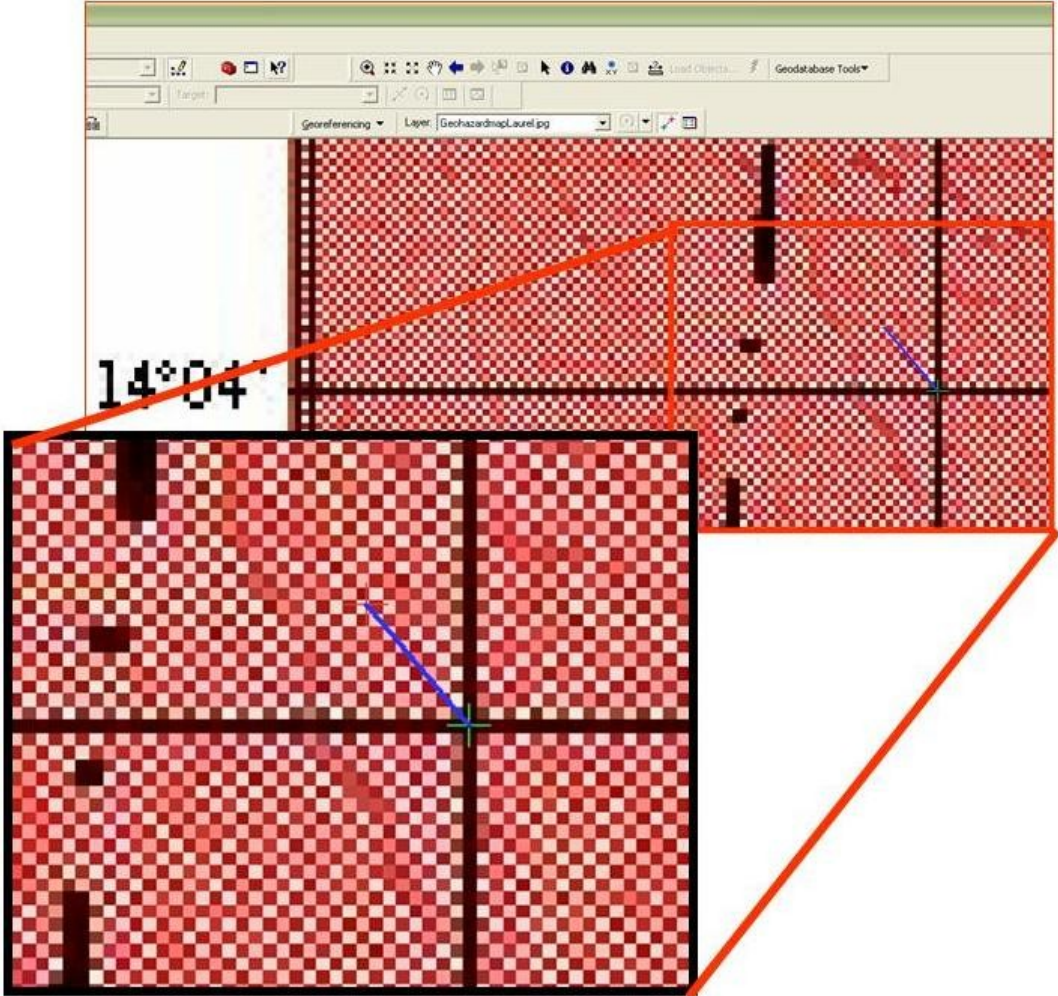


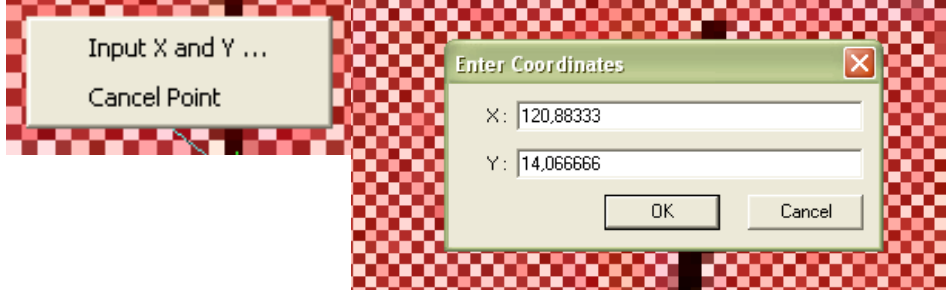
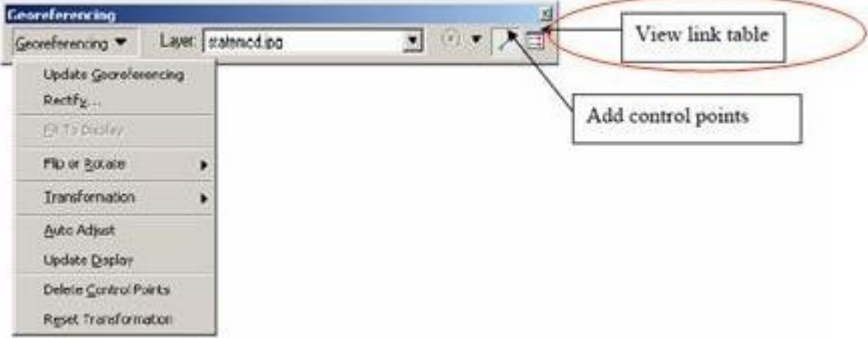
Image with our four control points.

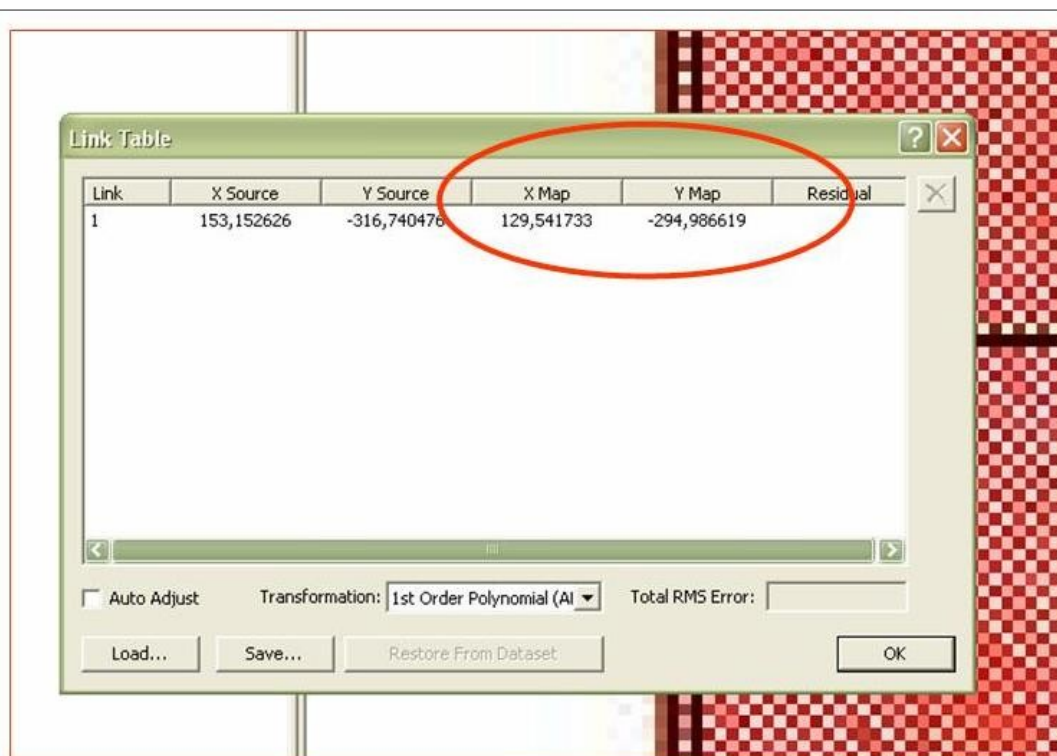
We will use the grid intersections 1-4 in the picture above as Control points. You find the Xmap and YMap values as LAT and LONG in degrees and minutes sign to the map grid lines at the left and at the top of the map. In this case the geographic coordinates are in degree-minute-second (DMS) format and we have to convert them to decimal degrees, see table below with the coordinates for the four control points. (120°30'30" is computed as follows: $120+(30/60)+(30/3600) = 120.50833333$).

Control pnt	Degree	Minute	Dec Degr(Xmap)	Degree	Minute	Dec Degr(Ymap)
1	120	53	120,8833333	14	4	14,0666667
2	120	57	120,95	14	4	14,0666667
3	120	53	120,8833333	14	1	14,0166667
4	120	57	120,95	14	1	14,0166667

Table with our control points' coordinates

4	<p>Adding Control points</p> <p>Click on the <i>Add control points</i> button in the <i>Georeferencing</i> tool bar (see image below).</p>
	
5	<p>Zoom extensively into control point number 1 (upper left point, refer to the image with our control points above). Place the cursor as accurately as possible on the point (see example below). Click the left mouse button once.</p>
	

6	<p>Move the cursor a short distance in any direction, then right-click. You see a line between a green point and a red point and a menu with two alternatives appear where the cursor is. Select Input X and Y... The <i>Enter Coordinates</i> window will appear, see below.</p>
	 <p>The image shows two overlapping windows on a red and white checkered background. On the left is a context menu with two options: 'Input X and Y ...' and 'Cancel Point'. On the right is the 'Enter Coordinates' dialog box, which has two input fields: 'X: 120.88333' and 'Y: 14.066666'. Below the fields are 'OK' and 'Cancel' buttons.</p>
7	<p>Enter the coordinates for the first control point (refer to table above). Then click OK.</p>
8	<p>Repeat step 4-7 for the three remaining control points.</p>
9	<p>Now you will verify that you entered the correct coordinates. To do this, click on the <i>view link table</i> button on the Georeferencing toolbar (see image below).</p>
	 <p>The image shows the 'Georeferencing' toolbar. The 'View link table' button, represented by a table icon, is circled in red. A callout box points to it with the text 'View link table'. Another callout box points to the 'Add control points' button, represented by a red crosshair icon, with the text 'Add control points'. A dropdown menu is open from the 'Georeferencing' button, showing options like 'Update Georeferencing', 'Rectify...', 'Fit to Display', 'Flip or Rotate', 'Transformation', 'Auto Adjust', 'Update Display', 'Delete Control Points', and 'Reset Transformation'.</p>
10	<p>The <i>Link Table</i> window appears (see image below). Verify that you entered the correct coordinates. If you have made a mistake it's easy to correct the coordinates by clicking in the coordinate columns (X Map or Y Map). You can also delete a control point by selecting the appropriate row in the <i>Link Table</i> window and pressing either <i>Delete</i> key on your keyboard or the <i>Delete</i> button, see second image below. If you do so, you have to repeat step 5-7 for the point that you've deleted.</p>



- 11 Check the *Total RMS Error*, which is found right above the **OK** button in the *Link Table* window. If this value is much higher than --- you have done something wrong with one or more control points. The point(s) with a high value in the *Residuals* column must be deleted and then re-added following step 4-7 again. If the *Total RMS Error* is acceptable click on **OK** to close the link table.

In the steps above you encountered a green and a red point when adding each control point. The green point (the one placed on the control point) is referred to as the 'source'. The red point (placed on a small distance away) is referred to as the 'target'. In our example this is somewhat theoretical, since we don't have to bother about the position of the red target point. This is due to the fact that we already have the real-world coordinates to the control points. In step 7 we provided ArcMap with these coordinates.

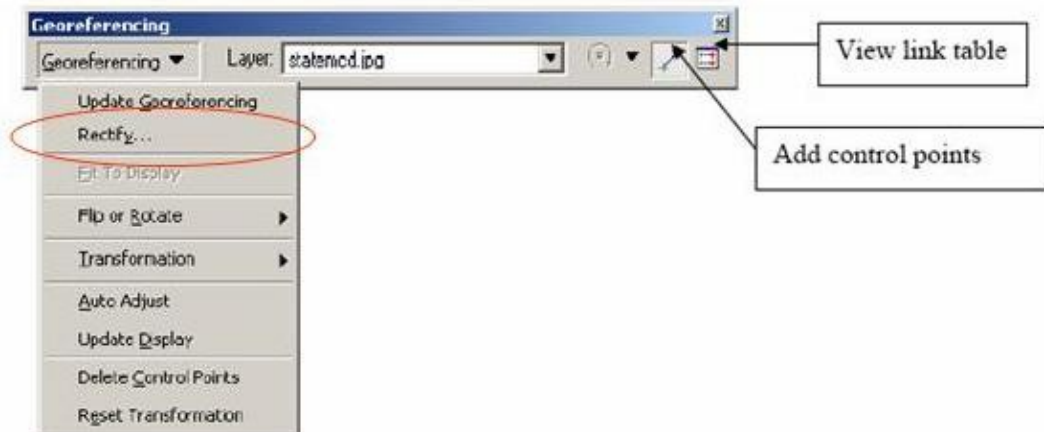
However, in other georeferencing cases we might not have a grid

with coordinates. In such cases we'll have other control points that consist of (for example) road intersections and buildings. If so, we first need to place the cursor in the same way as above, as precise as possible, on the control point. Then, we need to place the cursor (that is targeting the red point, also as precise as possible) on the corresponding road intersection/building in our reference data (which we in such cases would have added to ArcMap).

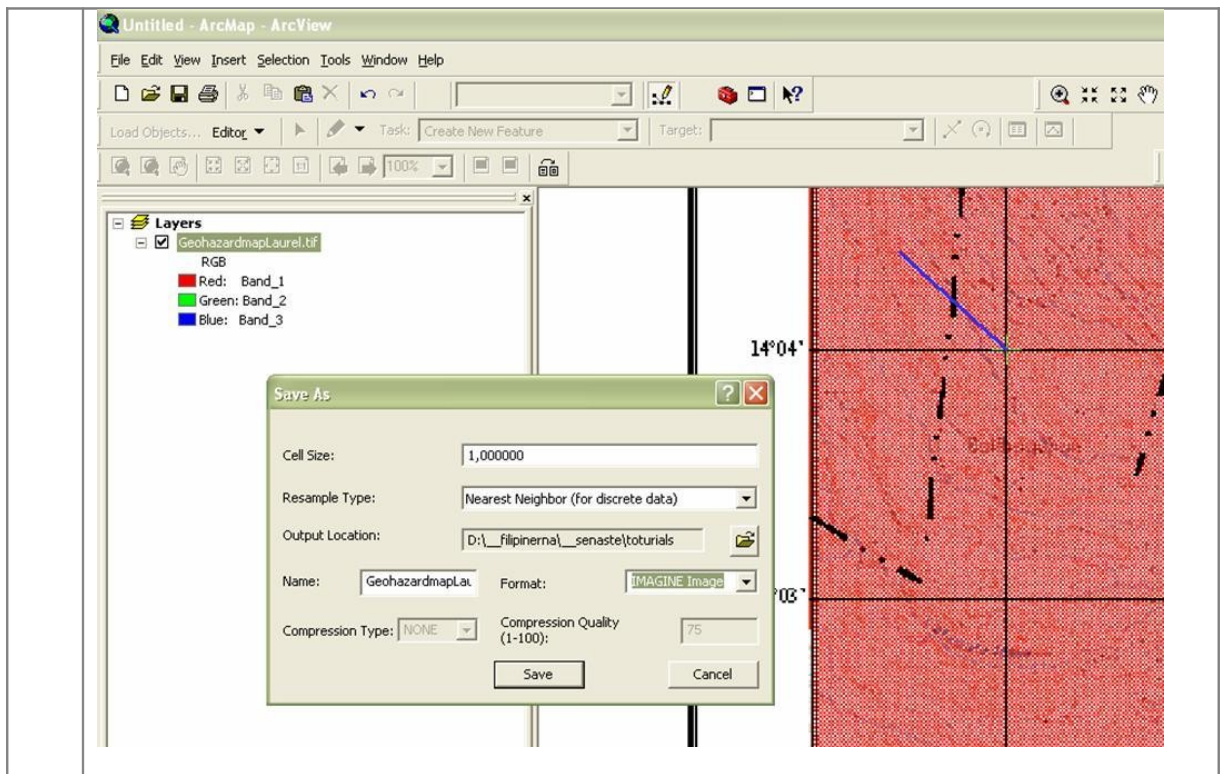
These are two examples on how we assign real-world coordinates to our control points. ArcMap will now calculate a formula to transform the image so that it fits the best possible to the chosen (target) coordinate system. The final transformation is known as rectification

Rectification

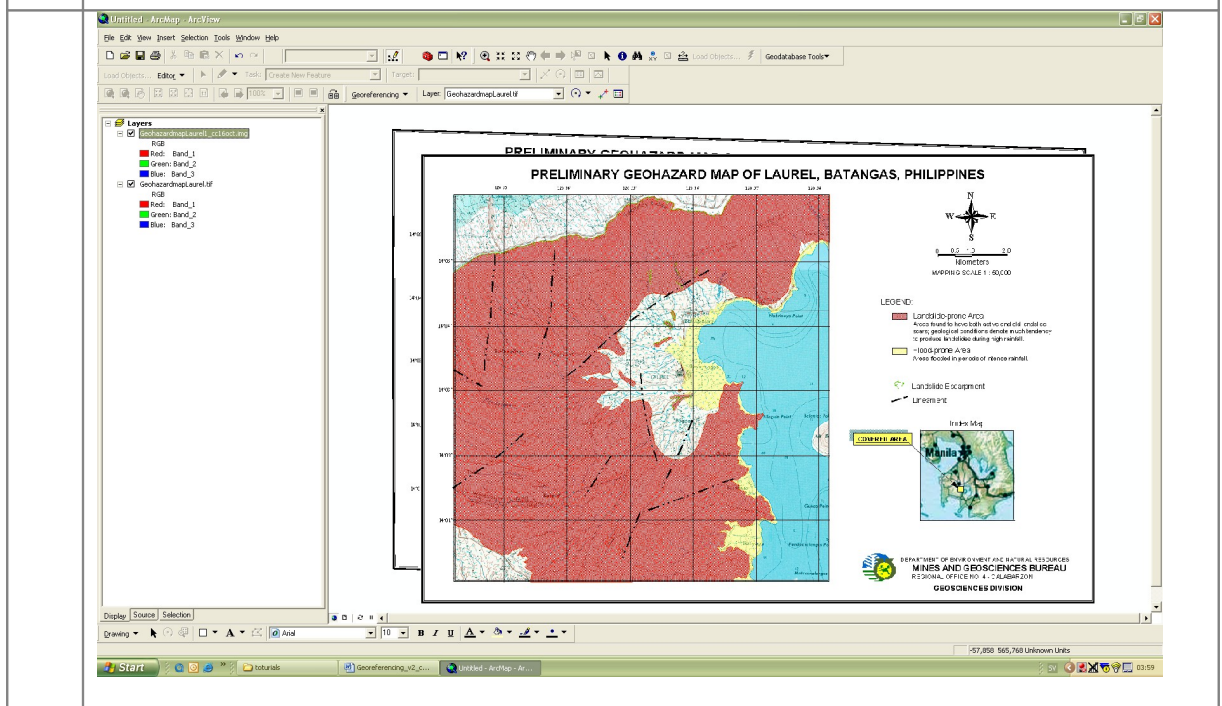
- 12 Select **Georeferencing > Rectify...** (see image below).



- 11 The Save As window appears. Don't change any of the default settings (if they are set as in the picture below). Click **Save** to start the rectification.



12 Select **Georeferencing > Update Display** to view your results. The Georeferencing procedure is now finished.



Using the Rectified Map

13 Add the following layers found in *C:\HLURB\CLUP\01_CLUPGIS* to the dataset:
 Layer1
 Layer 2

	<p>If these layers are atop of the geohazard image you have had success with this exercise. Congratulations!</p>
	<p><i>This exercise is now finished. An example of what you could proceed to do now is to digitize the different geohazards into different layers, and thus extend your CLUP digital dataset. For the sake of Laurel, this has already been done. Unless you don't want to rehearse your digitizing skills, you certainly don't have to carry on with this.</i></p>