

Rapid Land Cover Mapper (RLCM) Help Document

Requirements:

ESRI's ArcGIS ArcMap version 9.1 software at the minimum ArcView license level. The RLCM application has had limited testing in ArcGIS 9.2 and is not recommended for that version.

The Rapid Land Cover Mapper (RLCM) tool applies a vector/raster hybrid approach to multiple resolution and time series mapping of land use and land cover (LULC) and many other geographic themes. It is a standalone ArcGIS ArcMap (Windows platform) application and can be downloaded from the U.S. Geological Survey (USGS) RLCM web page (<http://edcintl.cr.usgs.gov/rlcm>). Conceptually, RLCM is based on the traditional dot grid (DG) method for calculating areas that has long been employed by foresters and other users of aerial photography. Using standard photo interpretation techniques, discrete LULC classes that touch each dot in the grid are identified by the interpreter. The RLCM tool facilitates the definition and generation of these dot grids, aids the selection of blocks of dots within common LULC classes, and applies the classification attribute to them.

Initial Project Setup:

The RLCM is designed to manage a single study area per ArcMap project file (file extension MXD). Before starting a land cover classification project using RLCM, the number of study areas must first be determined. Once determined, create a folder or directory for each study area and place a copy of the RLCM distribution file (see Appendix A) in each study area's folder. For each study area, follow these steps:

1. Determine Extent

Once the study area folders are created, the spatial extent of each study area must be determined in geographic coordinates based on the World Geodetic System 1984 (WGS84) datum. RLCM allows these coordinates to be entered either by uploading a

study area polygon as an ESRI shapefile or by manually entering the extent coordinates.

2. Preparing Imagery

RLCM allows the use of any type of image format that is supported by ESRI's ArcMap. The only requirements are that each image being used for interpretation have a defined coordinate system and a known acquisition date, and be entered in RLCM's image library (see Image Library Tool section for more details). Below are suggestions that will make entering images in the library more efficient:

1. Embed the acquisition date in the file name using a standard format such as the ISO date format of YYYY-MM-DD or (without the dashes) YYYYMMDD (19720210). RLCM does not support date formats with two-digit years, such as 10FEB72 for February 10, 1972 (See appendix B for a complete list of supported date formats). During the building of the image library, RLCM will try to extract the acquisition date from the file name. If RLCM cannot extract a date, it will add the image record, but leave the acquisition date field blank, requiring the user to enter the date manually. For further information on adding or modifying the acquisition date, see the *Image Library tool* section.
2. Image files being used for interpretation should be organized in a functional folder structure. RLCM allows the user to build the image library by searching recursively in selected folders for supported image formats. An image collection should be organized in separate folders, based on sensor type, time period, etc.

3. Installing RLCM

Once the RLCM distribution file has been acquired, copy it into each of the study area folders. Decompress and unpack the contents of the file into the study area folder by executing the distribution file. When the distribution file is executed, several files and a subfolder will be created inside the study area folder. All of these files are required for the operation of the RLCM tool and should not be altered. The

file named *rlcm.mxd* is the file that will need to be opened in ArcMap to start the tool. See Appendix A for details on each of the RLCM files.

Overview of RLCM's tool bar:



Figure 1: RLCM Toolbar.

1. Add Study Area button:

Initializes the dialog wizard to create a new study area. This wizard is also used to modify the study area description and append land cover classes to the Attributer listing (See *Add Study Area dialog window* section).

2. Load Dot Grid feature class button:

Load the DG feature class in the event that it is removed.

3. Store Dot Grid feature class symbology button:

Store the current symbology of the DG feature class in the RLCM database. We recommend that when a desired symbology is developed for the current DG, it is stored in the RLCM database. Storing the symbology in the database allows the symbology to be recovered in the event the DG feature class is removed. To restore symbology use the *Load Dot Grid feature class* button (2).

4. Manage Time Periods button:

Access the Time Period management dialog window. Within this window, time periods can be added and/or modified, and titles and descriptions can be edited.

5. Select Time Period drop-down menu:

Change current time period being classified (Figure 2).



Figure 2: Time Period Drop-Down menu

6. Dot Grid Attributer button:

Open RLCM's Attribute dialog window.

7. Exclusive Dot Grid Selection tool:

Select DGs with a common land cover class in exclusive mode or “*create new selection*”. Exclusive mode allows the selection of DGs using either of the 2 select methods (*regular polygon or irregular polygon*), but any current selection will be removed once a new selection is made.

8. Inclusive Dot Grid Selection tool:

Select DGs with a common land cover class in inclusive mode or “*Add to current selection*”. Inclusive mode allows the selection of DGs using either of the 2 select methods (*regular polygon or irregular polygon*) and will maintain previous selection.

9. Clear Select button:

Clear any selected DGs.


10. Local Registration tool:

Temporarily adjust imagery with poor spatial registration. This is a temporary correction and is only intended to be used to correct local (*interpretation scale*) spatial registration errors with respect to another spatial data set with the desired accuracy.

11. Image Library tool:

Access the Image Library management console. This tool is used to build and manage the image library.


Starting the RLCM Tool:

To start using the RLCM tool, open ArcMap and initiate the open project dialog box by either pressing the *Open Project*  button or selecting the File/Open menu option. Once the dialog is open, navigate to a study area folder and select the *rlcm.mxd* file. The first time that the RLCM project file is opened, several steps must be taken to set up the study area.

Initial Study Area Setup:

1. In order to use RLCM, a study area needs to be defined. When defining a study area, three questions must be answered:
 - What is the spatial extent (geographic coordinates) of the study area?
 - What land cover classification systems will be used?
 - What spatial resolution is appropriate for the study area?
2. To create a study area, press the “Add Study Area” tool (Figure 1, Item 1). This will initiate the study area dialog wizard which walks through several steps asking the above questions.
3. The next requirement is to define a time period. A time period can be set up by pressing the *Manage Time Periods* button (Figure 1, Item 4). A time period can be defined for any duration, from a single day to several decades. Time periods can be added or edited at any time, but may not be removed.
4. Another requirement is to build an image library. The image library is used to define a relationship between a classified DG and the image file(s) used to classify it. To build or manage the image library, press the *Image Library* button (Figure 1, Item 11). For further information see the *Image Library tool section*.

How to classify the dot grid:

To start classifying the DG, verify that the DG feature class is loaded in the table of contents (TOC) and visible (Figure 3). If the DG feature class is not loaded, press the “Load Dot Grid” button on the RLCM tool bar (Figure 1, Item 2). Next, select a time period to classify; for more information see “*Manage Time Periods*” Tool. Last, load images to interpret that fall within the selected time period and spatial extent of the study area. To load the images, use ArcMap’s *Add Data*  button. The only requirement is that the images selected have a record in the image library. If the images do not have a record, no classification can be applied to the DGs falling on those images.

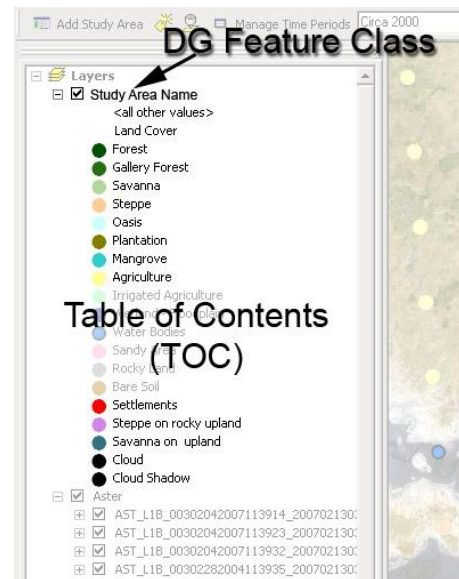


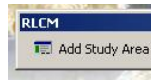
Figure 3: ArcMap Table of Contents

Once the DG feature class and valid image(s) are added in the TOC, the user can begin the land cover classification. Use a systematic approach to classify the study area. For example, a common approach is to first determine the appropriate scale to make an interpretation, then move through the study area at that scale from west to east. Choose a logical starting location in the study area, move to that location, then set the view to the appropriate scale within ArcMap’s active data frame or *viewing window*. Once the extent and scale are set, initiate the classification tool called the “*Attributer*” by pressing either the “*Dot Grid Attributer*” button (Figure 1, Item 6) or one of the DG selection tools (Figure 1, Items 7 and 8). This will open a floating dialog window showing the list of the classes selected during the initial study area dialog. With the *Attributer* open, choose a DG selection tool, either *exclusive* (Figure 1, Item 7) or *inclusive* (Figure 1, Item 8). With a selection tool select DGs with the same land cover class by clicking and dragging the cursor over the points. Once there is a collection of DGs selected with a common class type, choose that class from the *Attributer* dialog window. To commit that class attribute to the collection, either double click on the class type or choose the class type from the list and press the *Save Attribute* button located in the lower right of the

Attributer dialog window. RLCM then validates that each dot is on an image from the library, then stores the classification attribute along with the image used to make the classification, date attributed and study area.

An efficient method for classifying a *viewing window* is to determine the most common class in the window, select all the points within it, apply that class, and clear the selection using the *clear selection* button (Figure 1, Item 9) then systematically move through the window reclassifying all the DGs deviating from that common class. Continue with this approach throughout the study area until it is completely attributed. To classify this same study area for a different time period, simply add another time period by pressing the *Manage Time Period* button (Figure 1, Item 4). Once a new time period has been added, select it from the *Time Period pull-down menu* (Figure 1, Item 5) and follow the same approach as the previous period.

Add Study Area dialog window:



To begin a land cover classification using RLCM, the first steps are to build a DG feature class and a land cover classification table. The DG feature class is the matrix or grid of points that cover the extent of a study area. The land cover classification table or attribute table is where the land cover classifications are stored.

The first time the RLCM is used and the *Add Study Area* dialog window is opened, there are four steps that the wizard walks through:

1. Enter the name of the study area and a description (Figure 4). Entering the name of the study area is required and, once entered, the study area name cannot be changed. The description is an optional item and can be modified at any time by opening the *Add Study Area* dialog.



Figure 4: Step 1

2. At this step, the study area's spatial extent must be entered (Figure 5). There are two options to enter the extent: either upload an ESRI shapefile of the study area in geographic coordinates, or manually enter the extent in geographic coordinates (longitude/latitude).

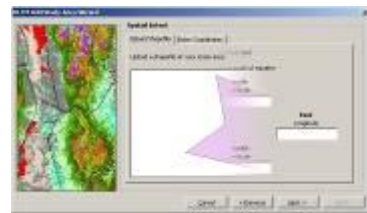


Figure 5: Step 2

By default, the shapefile upload option is presented. To enter the extent manually, select the *Enter Coordinates* tab.

3. Provide the spatial resolution of the DG matrix (Figure 6). This value represents the separation in meters between each point or DG. It also will be the pixel or cell size of the DG feature class when converted to a raster format.



Figure 6: Step 3

4. The final step (Figure 7) is to select a land cover classification system from the drop-down menu. Currently RLCM is delivered with four classification



Figure 7: Step 4

systems: 1. USGS Anderson Level II Land Use and Land Cover; 2. Global Land Cover 2000 (GLC2000); 3. U.S. National Land Cover Data 2001(NLCD); and 4. Sahel-West Africa Land Use and Land Cover. Once a classification system is selected, the bottom-left list box is populated with the complete list of classes. The next requirement is to select which classes will be displayed in the RLCM Attributer window. This allows you to minimize the number of classes to choose from while classifying. If some classes are not present in the study area, there is no reason to display them in the Attributer; removing them reduces the potential for misclassification. The Attributer class list can be appended to at any time during the classification processes, but no classes can be removed. If during the process of interpreting an image a class is not present in the Attributer list, it can be added by opening the *Add Study Area* dialog and navigating to the *Land Cover Classification System* step and moving the class from the left list box to the right list box.

Once all the steps are completed, the option is given to cycle back through each step to verify the inputs and change any item. When the verification is complete, move to the final step in the dialog and press the *Finish* button to build the DG feature class. This process may take several minutes (30+) to complete, depending on the density of the DG, the spatial extent of the study area, and the processing power of the computer building the data set.

Manage Time Periods tool:



Another requirement of RLCM is to specify time period(s) for a classification. These periods can range from a single day to decades. There is no minimum or maximum length for time periods, and no limit to the number of time periods. A time period can be modified at any time (Figures 8 and 9). The purpose of a time period is to provide a systematic method of organization, quality control, and more importantly, to allow for the assembly of land cover time series collections that can be accurately compared. An example of quality control is if you have selected the *c.2000* time period and are viewing an image that falls outside that time period, RLCM will not allow the classification of those DGs falling on that image. Only images falling within the selected time period can be used to classify the DGs. To change the time period during classification, simply select the desired time period from the *Time Period* drop-down menu (Figure 1, Item 5).

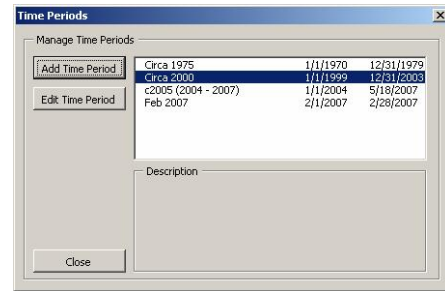


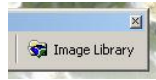
Figure 8: Time Period Dialog Window



Figure 9: Time Period Create / Edit Dialog Window

NOTE: RLCM does not allow a time period's date range (maximum - minimum) to be smaller than the date values applied during classification. The only case in which a time period's date range can be freely modified is before any classifications have been applied to the DG.

Image Library tool:



To build the initial Image Library or to append images to the library, open the *Image Library Management Console* by pressing the *Image Library* button (Figure 1, Item 11). This window displays all the images available to the RLCM for interpretation (Figure 10). It also provides access to the image metadata editor, labeled *Edit Metadata* and to the image search tool, labeled *Find Imagery*.

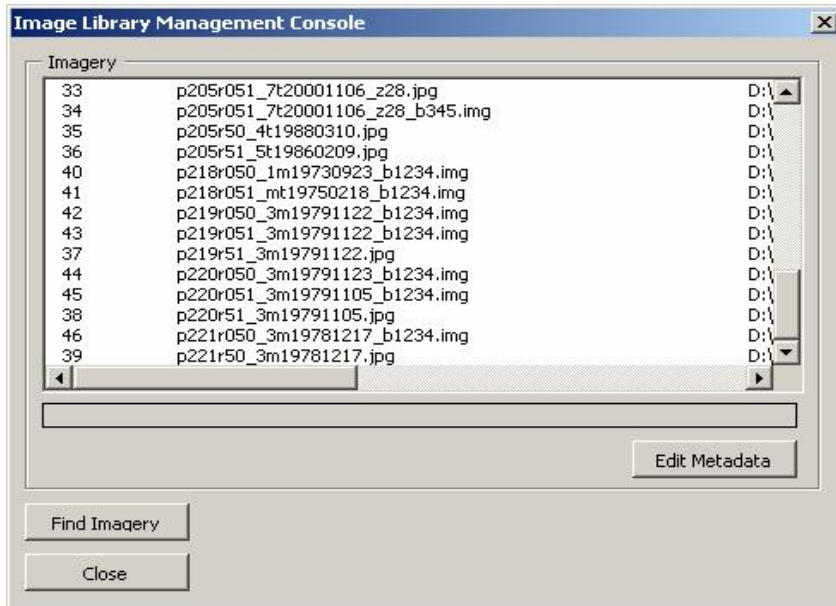


Figure 10: Image Library Management Console.

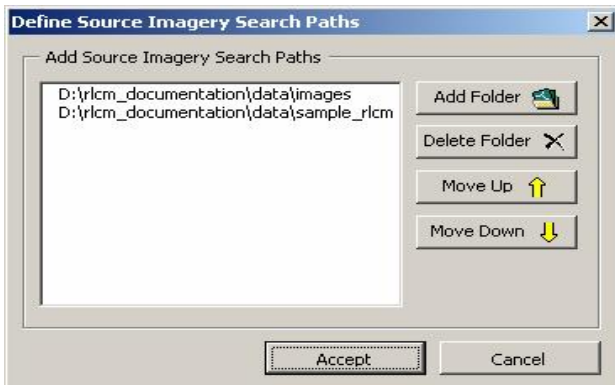


Figure 11: Source Imagery Search Paths.

To build the initial library or add image records to it, press the *Find Imagery* button. This button will open the imagery search path dialog window where RLCM can be directed to search for imagery (Figure 11).

If this is the first time building the Image Library, an image search path or paths must be defined. To define a path, press the *Add Folder* button; the *Choose Folder(s)* window will open. In that window, navigate to the location where the folder or folders that contain the imagery to be used for interpretation are located. Select the folder or multiple folders and then press the *Add* button. Continue this procedure until all the required folders are added to the list. If a folder is added inadvertently or is no longer required select it from the list and press the *Delete Folder* button. Folders are searched in the order displayed, so the first folder in the list is searched first and so on. To change the search order, select the folder to promote or demote and press the *Move Up* or *Move Down* button. Once the list is complete, press the *Accept* button. RLCM will then search all the folders listed recursively, looking for any image formats supported by ArcMap and adding them to the image library. Because folders are searched recursively, it is not

necessary to list folders in the search list that are subfolders of folders already listed. For example, if the folder *d:\landcover\images* is listed, it is not necessary to list *d:\landcover\images\landsat* because RLCM will automatically search the *landsat* folder because it is a subfolder of *d:\landcover\images*. If a new image data set is acquired and needs to be added to the library, either add the new folder to the list and press *Accept* or if the new set has been copied to a current folder in the list just press the *Accept* button. This will initiate the

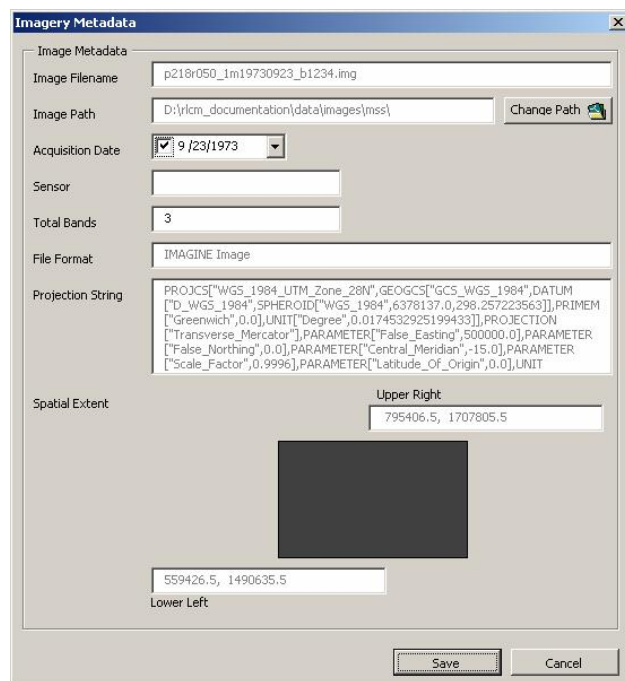
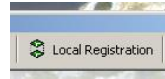


Figure 12: Image Library metadata editor window.

search and the new images will be appended to the library. Also, if an image data set is moved to a different folder, the same procedure is followed, but instead of RLCM adding records to the library it searches the library for the existing images and updates their file location.

Because RLCM requires that any image used for an interpretation must have a record in the library and an acquisition date to identify it, RLCM allows you to edit fields in an image's metadata record. To access this metadata, select the subject image from the list in the *Image Library Management Console* and press the *Edit Metadata* button (Figure 12). The *Image Metadata* window will open and display all the metadata stored by RLCM for that image. There are only three fields that can be manually edited: image path, acquisition date, and sensor type. If the image path needs to be changed, press the *Change Path* button to the right of the field, then navigate to and select the correct folder. If an acquisition date needs to be added or changed, either type in the correct date in the field or press the calendar drop-down tool and select the date. To edit the sensor type field, simply enter the sensor type in it. When all the edits are complete for the selected image, press the *Save* button at the lower right of the window.

Local Registration Tool:

The *Local Registration* tool (Figure 1, Item 10) provides a simple method for adjusting poorly registered imagery in the *viewing window*. This method simply shifts the selected image from one position to another as a way to temporarily correct for minor misregistration of images. To use this tool, identify a known location on both the poorly registered image and on a spatial data set with the desired accuracy. Once this point is identified, select the image to correct in the TOC, then press the *Local Registration* tool. After the tool is active, click the identified location or ***from location*** on the poorly registered image, turn the selected image's visibility OFF by removing the check mark next to it in the TOC, then click on the same location on the accurate data sets or ***to location***. The selected image will shift to that location (only vertical and/or horizontal shift). To see the results make the selected image visible again. Repeat the ***from*** and ***to*** location clicks until the desired correction is made. Depending on how poorly registered the image is and the geometry of the subject image, this operation may need to be applied several times during the course of classifying the image. We suggest that the image's registration be evaluated each time you move to a new *viewing window*.

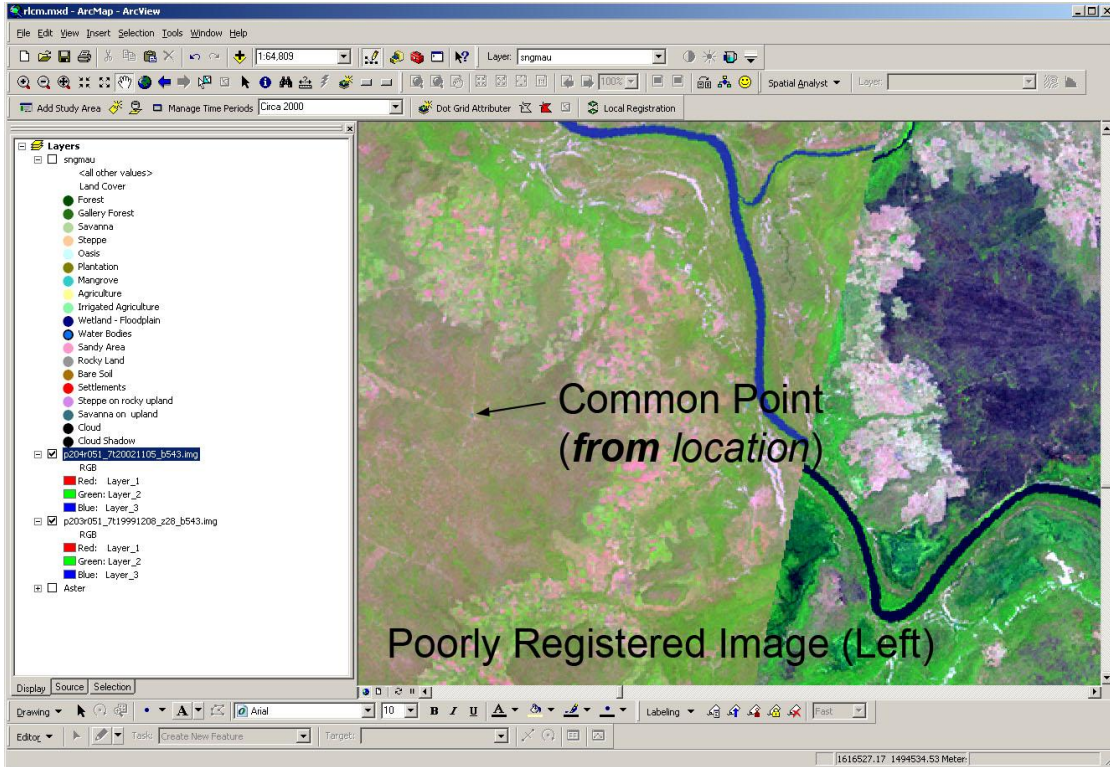


Figure 13: Common or from point indicated by arrow.

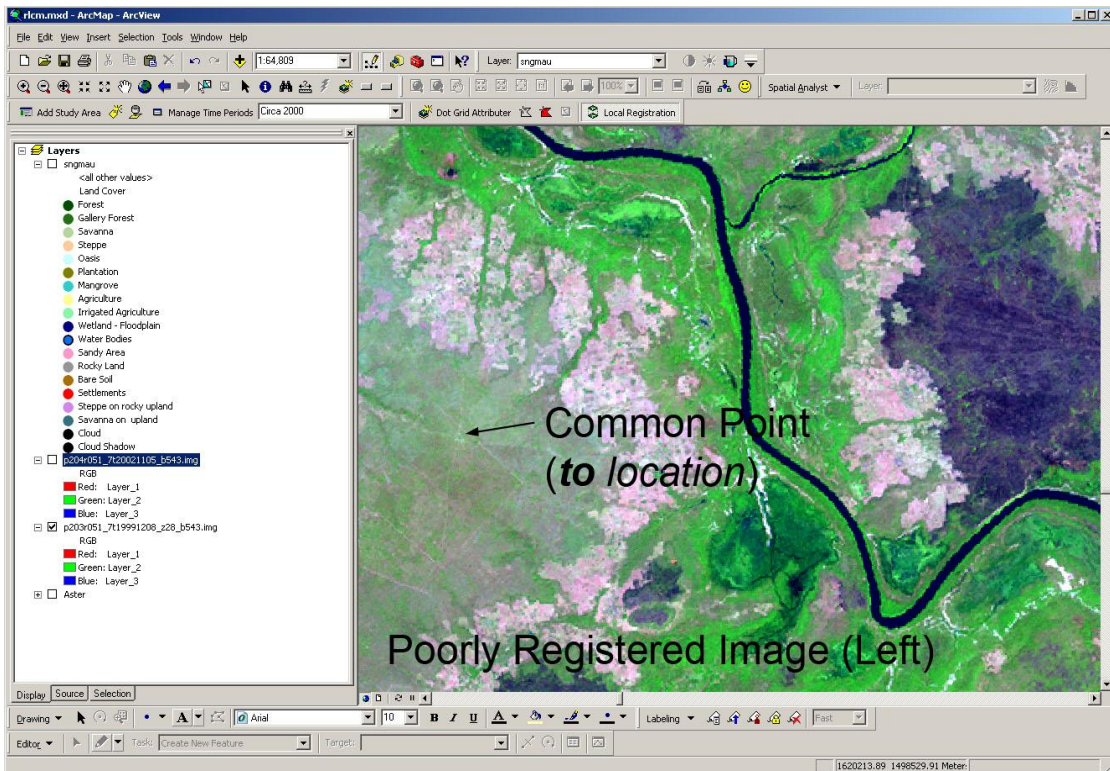


Figure 14: Common or to point indicated by arrow

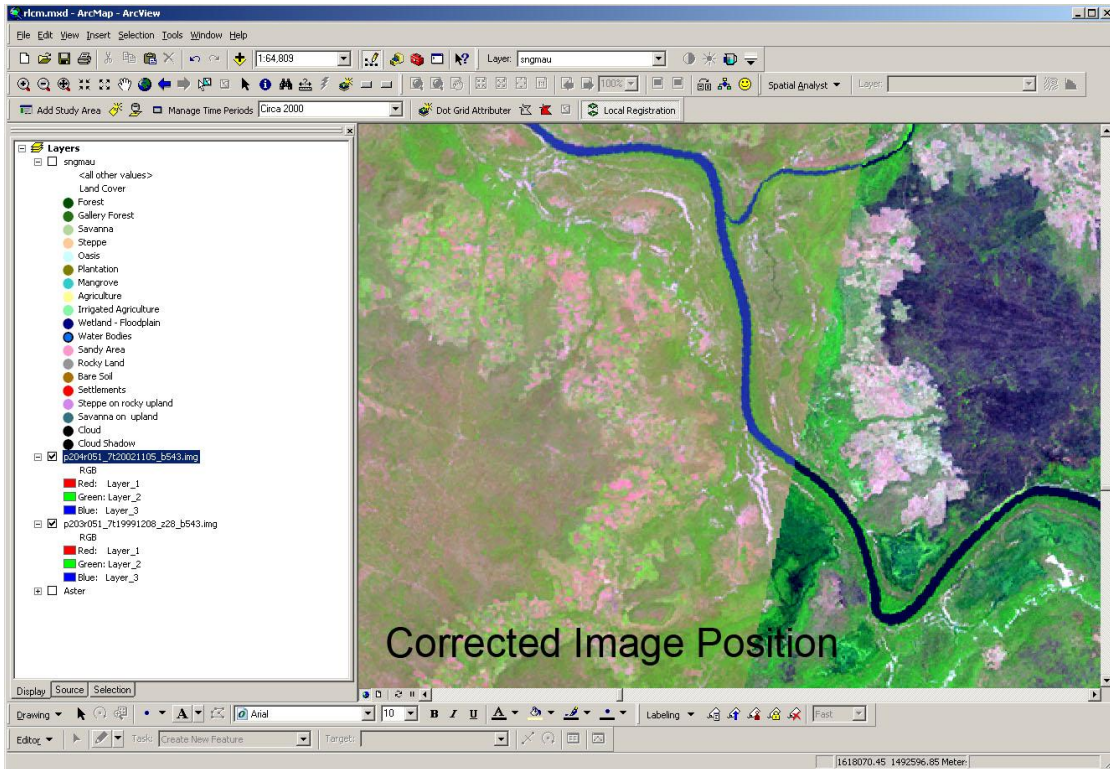



Figure 15: Applied correction shift results.

Exporting DG Data to Vector Format:

The DG feature class is built with several SQL expressions and is not a simple flat feature class. When a classification is complete or access is needed to the data in a standard format, it is important to understand how to export the data to a format that can be shared outside of the RLCM environment. The DG feature class data can be exported only for a single time period. The export process has two steps: first, select the time period for export from the *Time Period drop-down menu* (Figure 1, Item 5); second, right-click on the DG feature class in the TOC and select the Data/Export Data option. This dialog allows the option to export the DG into two different formats, either ESRI shapefile or a Personal Geodatabase. If the data are exported to an ESRI shapefile, the field names will be truncated if they exceed 10 characters in length.

Exporting DG Data to Raster Format:

In many situations, land cover data sets are required to be in a raster format for processing in models. Using standard ArcGIS tools available in ArcToolBox, the DG feature class can be converted to a raster format for any selected time period. First, select the time period to be exported, then open the ArcToolBox window by pressing the

ArcToolBox button  within ArcMap. Once the window is opened, navigate to the *Feature to Raster* tool (*ArcToolBox/Conversion Tools/To Raster/Feature to Raster*). Open the tool and provide the required input information. For the *Input Feature* select the RLCM DG feature class; for the field input select the *dot_grid_attribute.lc_class_code* field. In the *Output raster* field provided a descriptive name that includes the time period of the raster data set. In the *Output cell size* field, indicate the cell size, which should be the same as the DG resolution selected during the

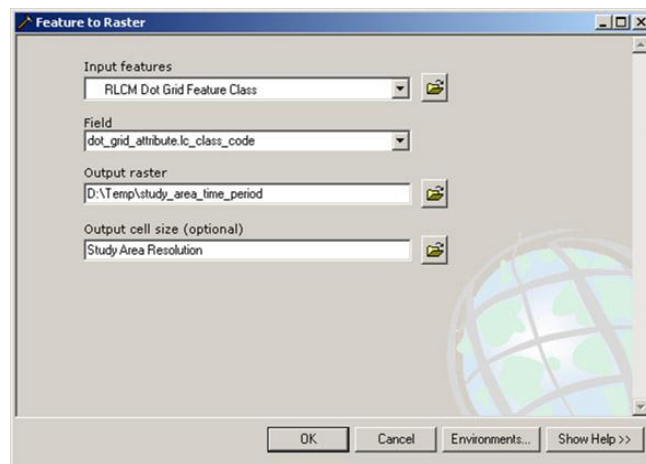


Figure 16: Feature to Raster dialog window

initial study area setup. Press *OK* once all the input fields are completed and verified. ArcGIS will convert the DG feature class to a raster format; conversion may take several minutes to complete, depending on the density of the DG matrix.

NOTE: *Raster output may vary depending on the default and custom settings specified in the ArcToolBox Environment setting; see ArcGIS documentation for further details on these settings.*

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Appendix A: RLCM distribution file and required files.

Description of the contents of the RLCM distribution file:

RLCM is distributed from the USGS RLCM Web site (URL) as a self-extracting executable file labeled *rlcm_distro.exe*. When executed, the file is decompressed and its contents are unpacked into the file location where it was executed. The contents of the distribution file are as follows:

- **rlcm21pyv2** folder: This folder contains Python language scripts that are required to build the study area Dot Grid matrix. The files within this folder are:
 - `__init__.py`
 - `__init__.pyc`
 - `buildmagetable.py`
 - `dgmm.py`
 - `dgmm.pyc`
- **rlcm.mdb**: This is the ESRI Personal Geodatabase file and is the location where all of RLCM's spatial data and related attribute tables are stored. We strongly recommend that this Geodatabase not be modified outside of the RLCM environment.
- **rlcm.mxd**: This file is the ESRI ArcMap project file and contains the user interface and code required to operate the RLCM tool.
- **rlcm_bldg.py**: This is a Python language script that allows ArcMap to interface with the other Python modules (files) located in the `rlcm21pyv2` folder.
- **rlcm.xml**: Although this file is not present when the distribution file is unpacked it is created the first time that the `rlcm.mxd` is opened in ArcMap. This file stores configuration settings for the RLCM project.

Appendix B: Valid date format strings.

Date masks:

YYYY = 4 digit year representation (example: 1998)

MM = 2 digit month representation; if month digit is less than 10 always precede value with 0 (example: 08 = August)

MMM = 3 character month representation (examples: FEB = February, MAR = March, etc.)

DD = 2 digit day representation; if day digit is less than 10 always precede value with 0 (example: 01 = the first day of the month)

JUL = Julian day or day of the year (example: 1998213 = August 1, 1998, August 1st being the 213th day of 1998)

Supported Formats:

YYYY-MM-DD (1998-08-01 = August 1, 1998)

YYYYMMDD (19750619 = June 19, 1975)

DDMMYYYY (10021972 = February 10, 1972)

DDMMMYYYY (01JAN2001 = January 1, 2001)

MMDDYYYY (09302002 = September 30, 2002)

YYYYJUL (2005205 = July 24, 2005)