



Rapid Land Cover Mapper (RLCM)

An introduction to the USGS's Rapid Land
Cover Mapper tool

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U.S. Department of the Interior
U.S. Geological Survey

Learning Objectives

- After completing this:
 - understand what RLCM is used for;
 - know the benefits of using the RLCM tool;
 - have a conceptual understanding of when, where, and how to use the tool;
 - appreciate the inherent quality control features of the tool;
 - recognize the benefits of a nested point matrix (dot grid) dataset.

RLCM Overview

- What is RLCM?
- Why was RLCM developed?
- What is the objective of this application?
- How does RLCM work?

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

What is RLCM?

- The RLCM tool is a vector/raster hybrid approach to land use land cover (LULC) mapping. It lends itself to both multipleresolution and time series mapping of LULC and many other geographic themes.
- Conceptually, it is based on the traditional dot grid method for calculating areas that has long been employed by foresters and other users of aerial photography.

Source: USGS, 2007a

What is RLCM?

How it works:

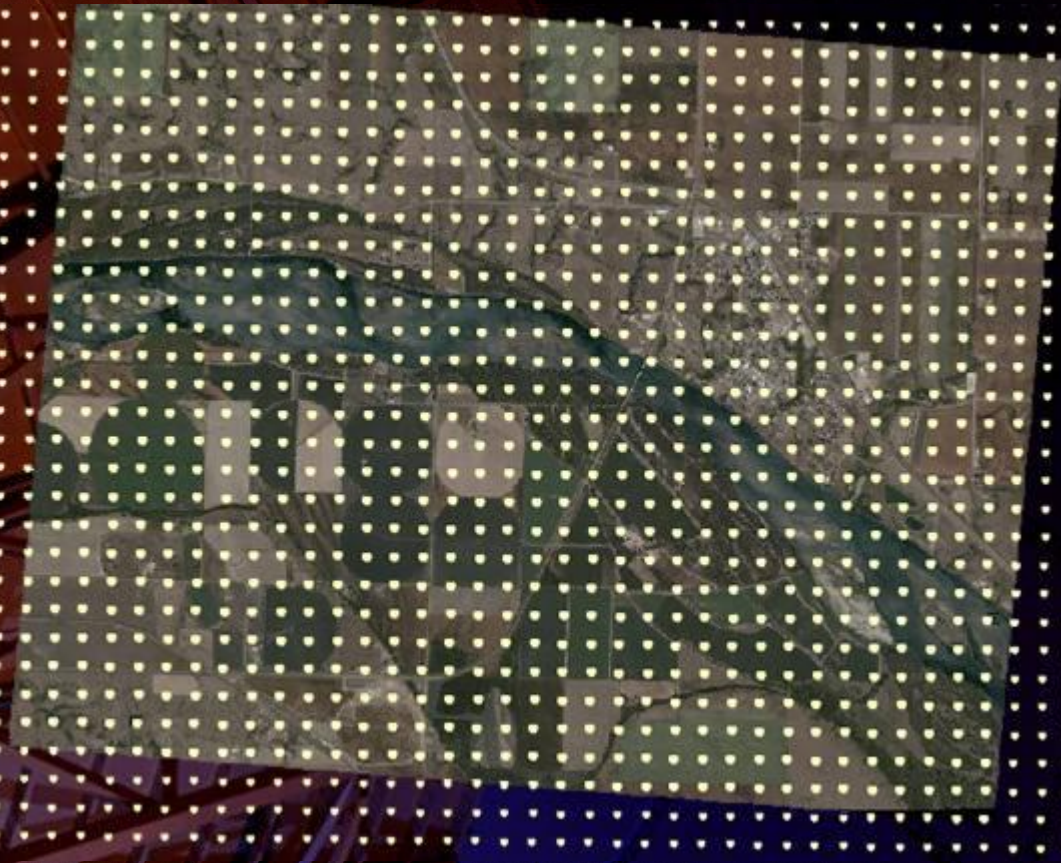
- The RLCM tool first generates a digital dot grid for a given study area. Then it overlays that dot grid on an image within ESRI's ArcMap GIS software.
- Using standard photo interpretation techniques, the analyst identifies the discrete LULC class for each dot. The RLCM tool facilitates both the selection and attribution of the dots within a common LULC class.
- It also facilitates the management of multiple time period classifications for the study area.

Source: USGS, 2007a



What is RLCM?

An example of a dot grid matrix created by RLCM.



What is RLCM?

Here is an illustration of the same dot grid that was built on three time periods.

2002 Dot grid

1960 Dot grid

1920 Dot grid

What is RLCM?

Once the dot grid matrix is completely classified for a given time period, a raster LULC map can be generated. The same process can be applied to different time periods and the resulting maps can be compared to assess change over time.

RLCM History

RLCM was initially developed to expedite the LULC classification of sub-Saharan West Africa. The requirements for this project were to develop a tool that would:

1. facilitate LULC classification of Sub Saharan West Africa at an appropriate scale;
2. implement an efficient method of classifying LULC at that scale while preserving optimal detail;
3. allow for accurate time series comparisons;
4. be easy to use, minimizing the learning curve;
5. keep implementation costs and software requirements to a minimum.

RLCM History

Results:

1. Facilitate LULC classification of sub-Saharan West Africa at an appropriate scale.
2. Implement an efficient method of classifying LULC at that scale while preserving optimal detail.

Creation of the dot grid hybrid approach allowed users to create a matrix of points at an appropriate resolution for a defined region.

3. Allow for accurate time series comparison.

Development of the tool to leverage ArcGIS's Geodatabase technology allowed for the transparent management of multiple time periods.

RLCM History

Results:

4. Easy to use, minimizing the learning curve.

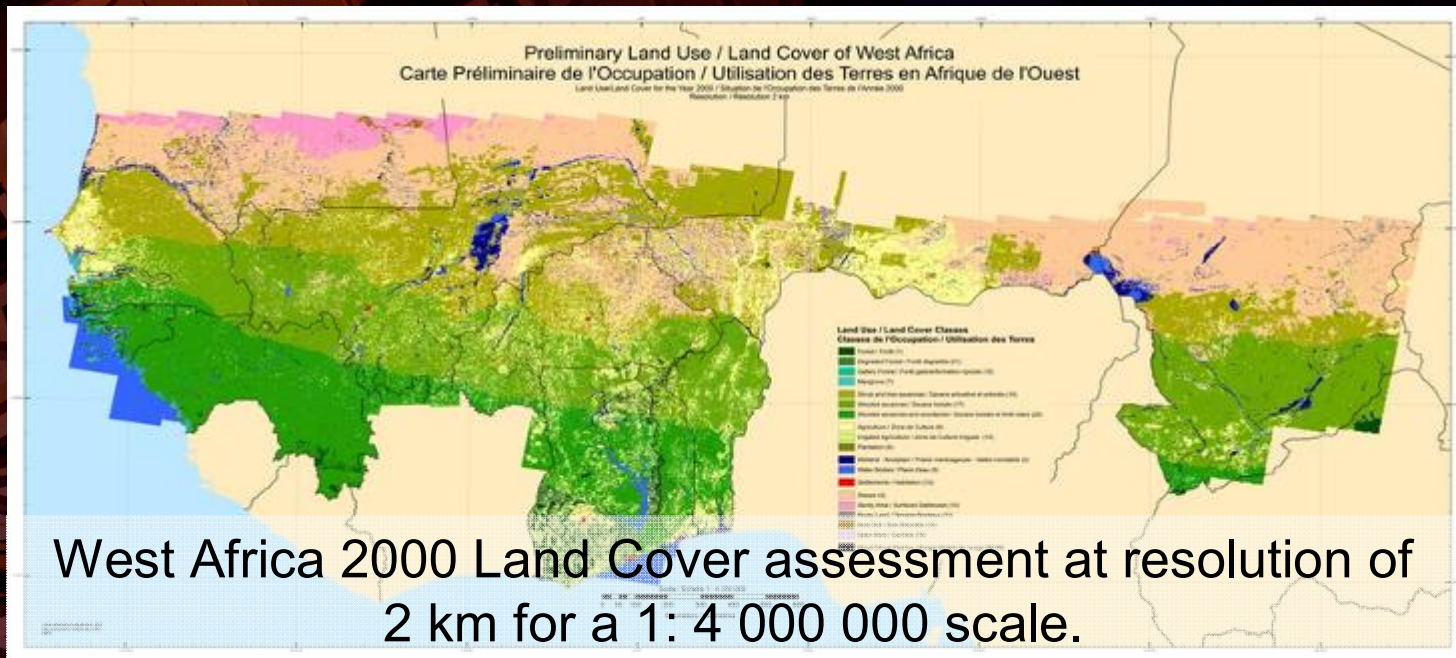
Development of a tool within ESRI's ArcMap software established a simple user interface that requires only basic GIC and ArcMap software skills.

5. Low implementation cost and minimal software requirements.

Using ESRI's ArcGIS desktop software at the ArcView license level minimizes software cost without compromising functionality.

Objective of RLCM

The objective of RLCM is to facilitate LULC classification of an area at a defined scale and resolution for multiple time periods.



Source: USGS, 2007b

RLCM Benefits

- RLCM enables an analyst to compare images from many different sources.
- Using local knowledge, photo interpreters are able to integrate many different landscape characteristics into an interpretation.
- The method is relatively rapid mapping for a large area.
- RLCM is effective for time series mapping because the interpreter can determine whether real LULC change has occurred at each dot over time.
- It allows the use of nested dot grids for the creation of multipleresolution LULC datasets.
- It's easy to use.

Source: USGS, 2007a

Using RLCM, An Overview

- Planning
 - Determine spatial extent and resolution of study area.
 - Identify the required time periods.
 - Determine the classification system to use.
- Preparation
 - Collect and prepare imagery to be used in RLCM.
 - Set up RLCM software.
 - Build RLCM image library.
 - Define time periods within RLCM.
 - Import LCCS classification, if required.
 - Build study area with RLCM.
- Product development
 - Classify study area for all time periods.
 - Export RLCM time period data for analysis.
 - Product development workflow.



RLCM

PLANNING

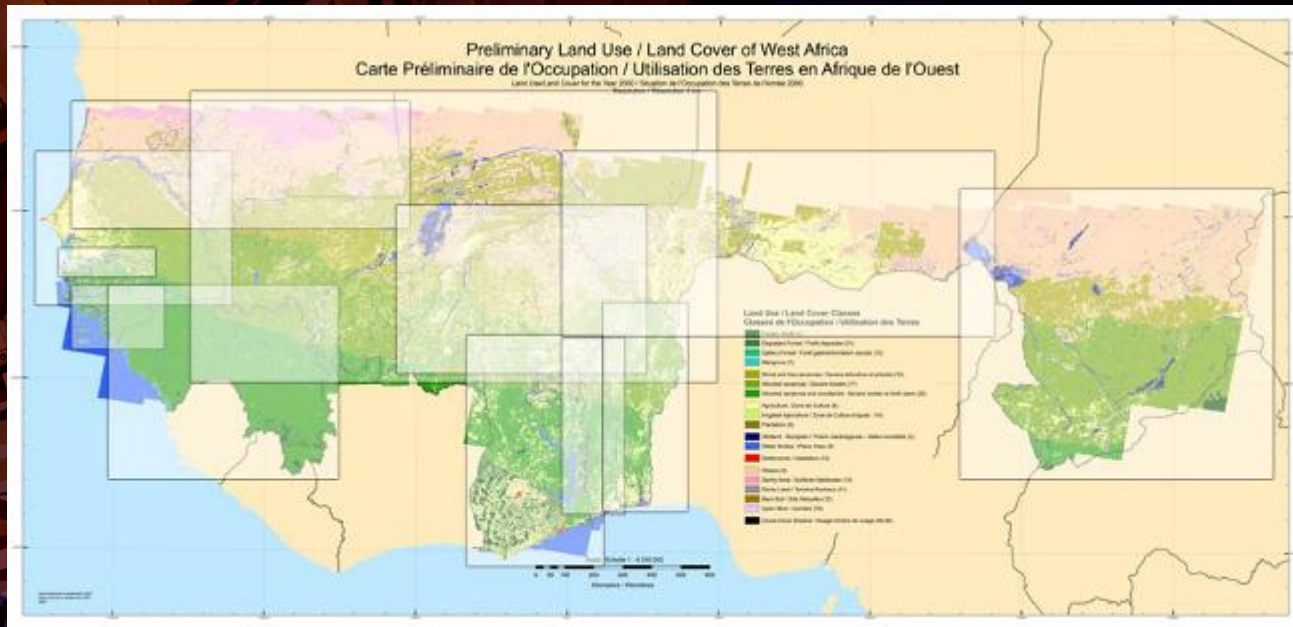


Planning: Study Area

- Determine spatial extent of study area
 - Is covering multiple time periods a requirement?
 - Does the study area have the potential to expand spatially? What is the maximum extent?
- Determine how much detail (spatial resolution) is required of the classification

Planning: Study Area

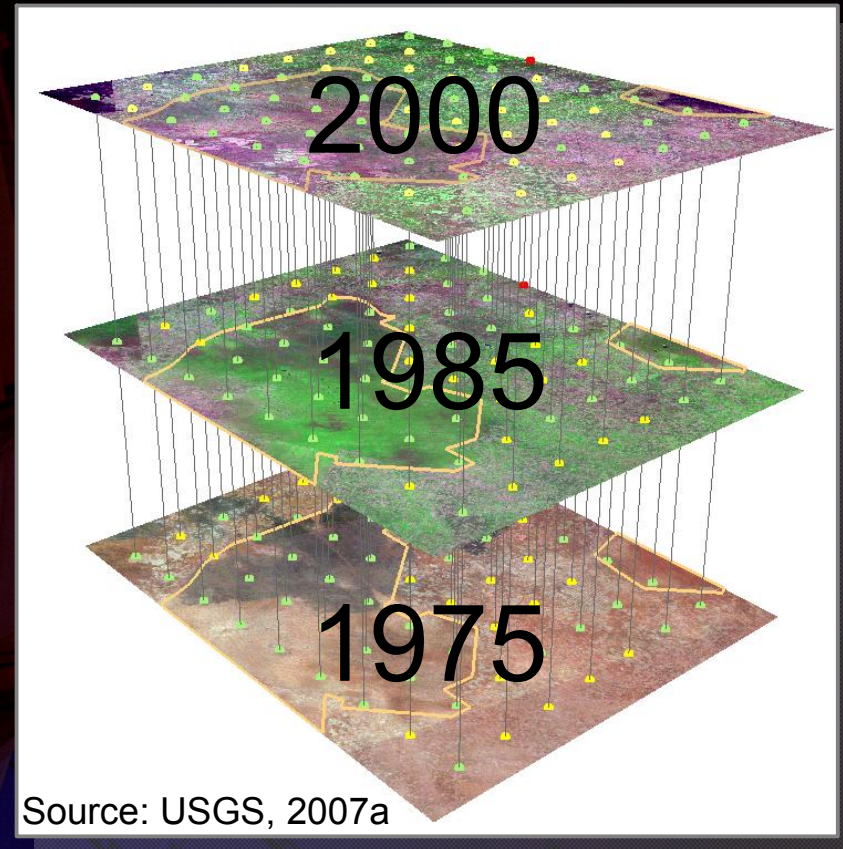
- Example: sub-Saharan West Africa study areas were defined by the extent of the participating country. All study area resolutions were set at 2 km, considering the vast scope of the project.



Source: USGS, 2007b

Planning: Identify Time Periods

- Time periods are defined as a range of dates for which the LULC classification is interpreted.
- RLCM has no restriction on the number of time periods applied to a study area.



Planning: Classification System

- Determine the LULC classification system.
 - Select which classification system of the five available in RLCM or import a Land Cover Classification System (LCCS) legend file. For more information on LCCS, visit GLCN-LCTC's web site (<http://www.glc-lccs.org/>).
 - Supported classification systems:
 - Anderson land use and land cover (Level II)
 - Crop/Non-Crop (Food security assessment)
 - Global Land Cover 2000 (GLC2000)
 - Sahel-West Africa Land Use/Land Cover
 - United States National Land Cover Data (NLCD)
 - If an LCCS classification has been defined for the study area, export the legend file to an XML format for import into RLCM.
- If an appropriate system is not available in RLCM, contact the support person listed on the RLCM web site for additional assistance (<http://edcintl.cr.usgs.gov/rlcm>).



RLCM

PREPARATION



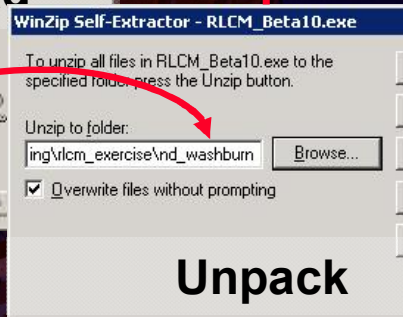
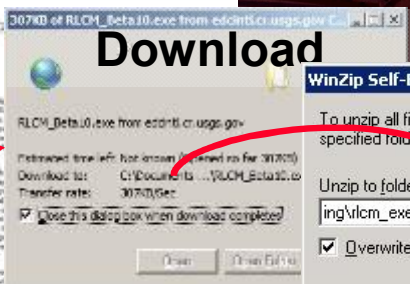
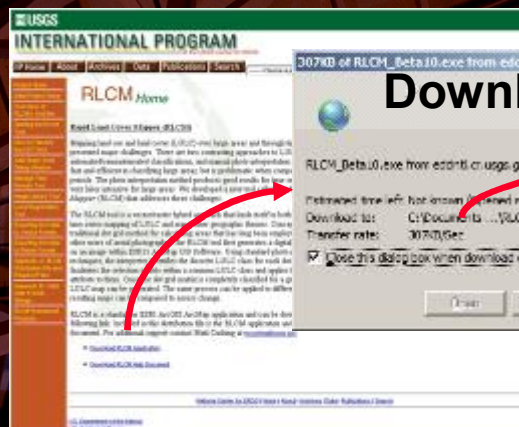
Preparation: Collect and Prepare Imagery

- Collect and prepare imagery for interpretation in RLCM.
 - Gather all images used for interpretation in a single location and organize them by time periods.
 - Verify that all imagery have a defined spatial projection.
 - All file formats are supported by ESRI software.
 - All images have a known acquisition date and ensure that it is embedded in the image filename following RLCM criteria (See appendix B in the RLCM Help document).

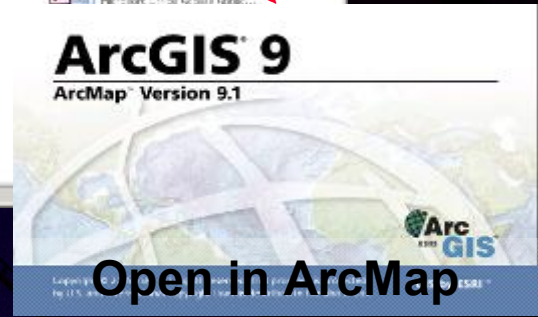
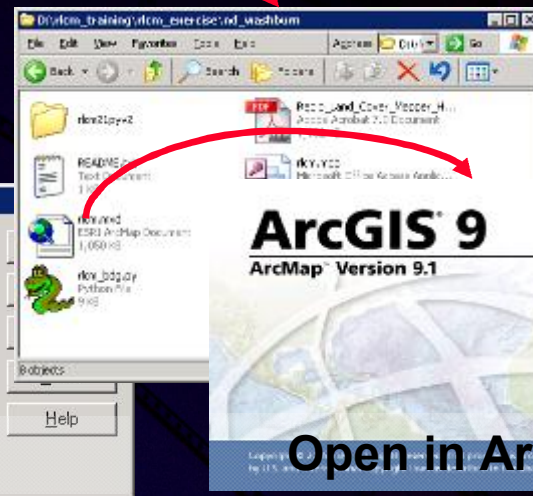


Preparation: Set Up RLCM

- RLCM requires that you have ESRI's ArcGIS 9.1 software installed at the minimal ArcView license level.
- Download the latest version of RLCM from its web site (<http://edcintl.cr.usgs.gov/rbcm>).
- Unpack the contents of the compressed distribution file (RLCM_<version_number>.zip).



Unpack



Open in ArcMap



Preparation: Build an Image Library

- RLCM requires that all the imagery being used for interpretation be entered into an image library.
- The library stores important metainformation listed below for each image.
 - Image filename and path
 - Image acquisition date
 - Sensor type
 - Number of bands available in the image
 - File format in which the image is stored
 - Projection information
 - Spatial extent
- To build the library, you must identify the folders containing the images to be used through an RLCM interface. RLCM then searches each folder listed for supported file formats and populates the library, extracting the information listed above.

Preparation: Build an Image Library

- RLCM uses the library for several tasks.
 - It creates a relationship between each dot grid classified and the library. This way you can identify which image was used to classify each dot.
 - It validates that the dot grids being classified are falling on a valid image.
 - It validates that the image being interpreted falls within the time period being classified.

Attributes of image_library_lookup

OBJECTID	filename	file_path	acquisition_date	sensor	total_bands	file_format	spatial_reference	spatial_extent	layer	
12	nd_washburn_julc_200	D:\lcm_training\lcm	9/30/2002		3	TIFF	343435.691813738	5 Blob		
13	nd_washburn_julc_200	D:\lcm_training\lcm	9/30/2002		3	TIFF	340163.692821478	5 Blob		
14	nd_washburn_julc_200	D:\lcm_training\lcm	9/30/2002		3	TIFF	343290.526316414	5 Blob		
15	nd_washburn_julc_200	D:\lcm_training\lcm	9/30/2002		3	TIFF	339690.416011098	5 Blob		
16	nd_washburn_julc_192	D:\lcm_training\lcm	1/7/2001		5	TIFF	338534.650660034	5 Blob		
17	nd_washburn_julc_600	D:\lcm_training\lcm	<Null>		3	TIFF	PROJCS"WGS_1984	339953.526642731	5 Blob	

Record: 1 | Show: All | Selected | Records: (0 out of 6 Selected) | Options

Image Library Table



Preparation: Define Time Periods

- Another requirement of RLCM is to specify time periods for classification.
 - Time 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.
- The purpose of a time period is to provide a systematic method of organization, quality control, and more importantly, the assembly of land cover time series collections that can be accurately compared.

Preparation: Import an LCCS File.

- RLCM does allow you to import a Land Cover Classification System (LCCS) legend in XML format.
 - An LCCS legend is a method of applying an abstract LCCS classification to the study area at a defined scale and dataset (Gregorio, 2000). If you have an LCCS legend developed using LCCS's software, you can export that legend to an XML format for import into RLCM.
 - LCCS is a comprehensive hierarchical classification system developed by the Food and Agriculture Organization (FAO) of the United Nations. For more information on the this system, visit the GLCN-LCTC web site (<http://www.glcnlccs.org/index.php>).

Preparation: Build a Study Area

- RLCM has a five step wizard that walks users through the process of building a study area. These steps should be a simple task of entering the appropriate information because all the details were determined earlier in the planning stages.
- The information required for the wizard is:
 1. Name of study area and description
 2. Spatial extent (import ESRI Shapefile or bounding coordinates)
 3. Indicated spatial resolution
 4. Necessary classification system



RLCM

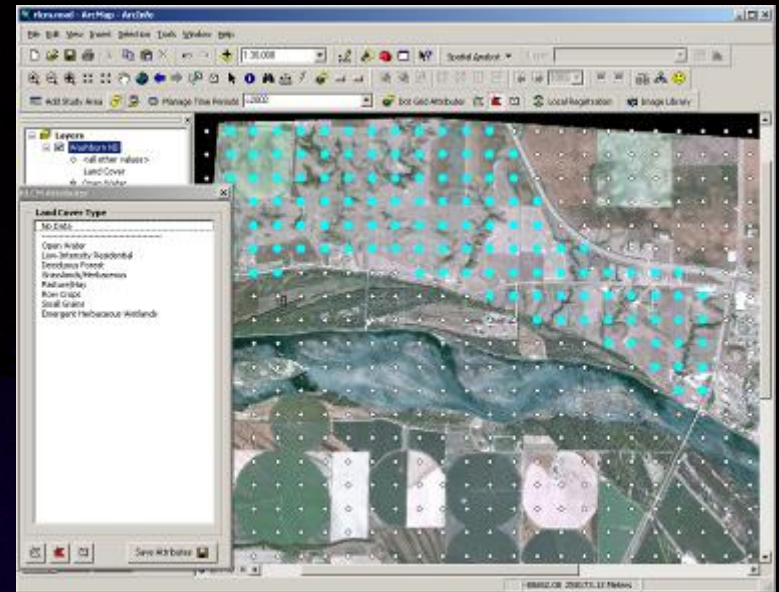
PRODUCT DEVELOPMENT



Product development: Classify Dot Grids

■ Steps in classifying dot grids

1. Select time period.
2. Load images to be interpreted.
3. Open the dot grid attributer.
4. Select the dot with a common classification.
5. Apply the classification to the selected dot grids.
6. Continue to apply classification until all dot grids are classified for the study area.
7. Export dot grid to vector format, raster format or both.
8. Repeat for all time periods defined.



Product Development: RLCM Features

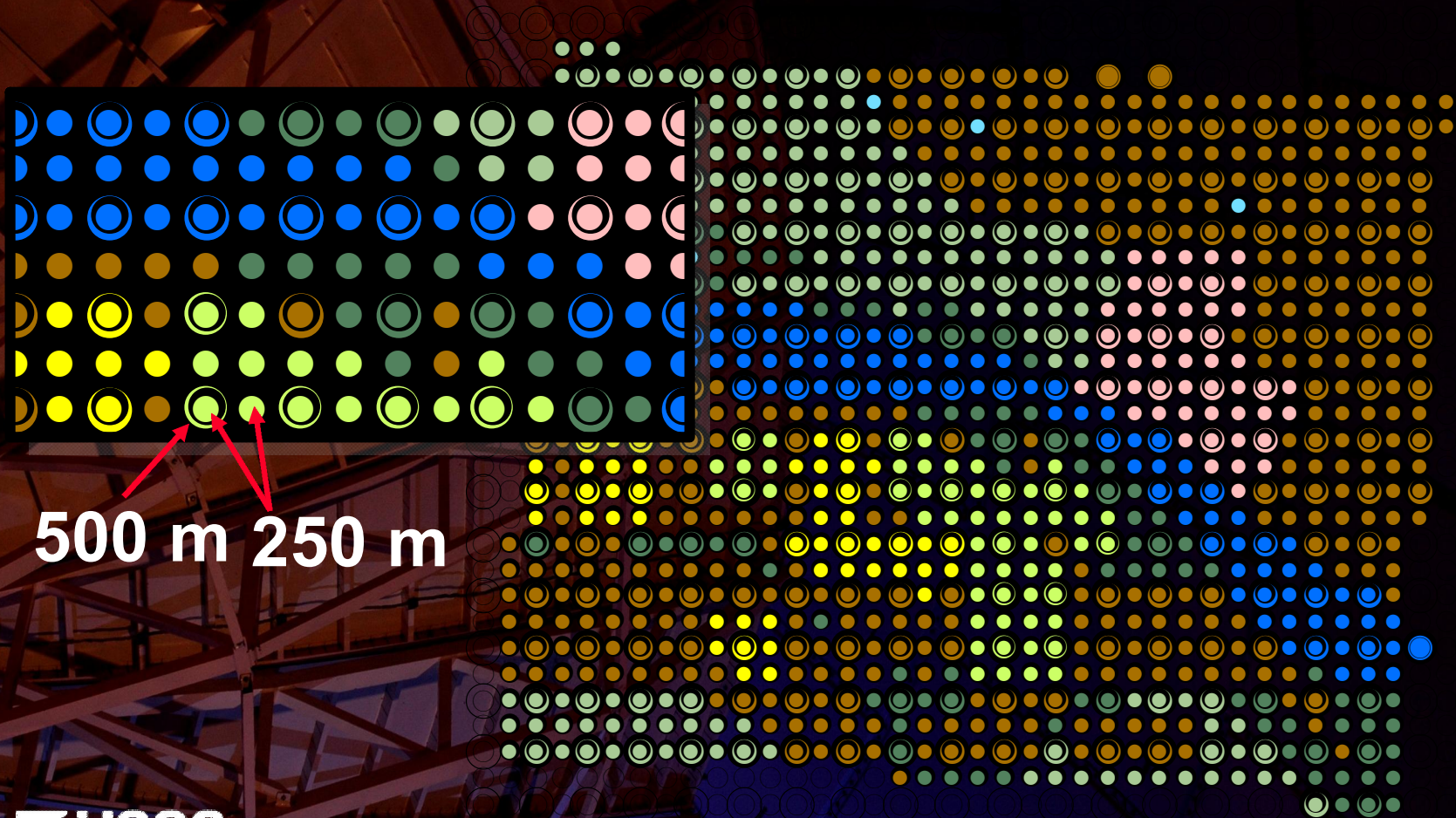
- Time Period Attribute Control:
 - Allows only images falling within selected time periods to be used to classify the dot grids and prevents inadvertent classification of images falling outside the period.
- Local Registration Tool:
 - Allows for temporary correction of poorly georeferenced images.
- Continuous database updating – dot grid classifications are continuously saved.
- All dot grid matrixes are built using a common coordinate system and reference points.
 - Allows for building multiresolution classification layers.
 - Creation of inherent nested datasets.

Product Development: RLCM Features

- Nested dot grid concept:
 - Allows for building multipleresolution datasets.
 - High resolution for urban or high interest areas
 - Lower resolution for regional or homogeneous areas.
 - Allows for simpler exchange of data – all users interrupting common points.
 - Inherent consistency in building time series data.
 - Example: A 1965 LULC assessment at 500m using Corona images, 1975 assessment at 1000m using MSS, and a 1990 assessment using TM at 500 m. With a nested dataset a change analyst for all periods can be completed at 1,000 m because all time periods have common points at that resolution.

Product Development: RLCM Features

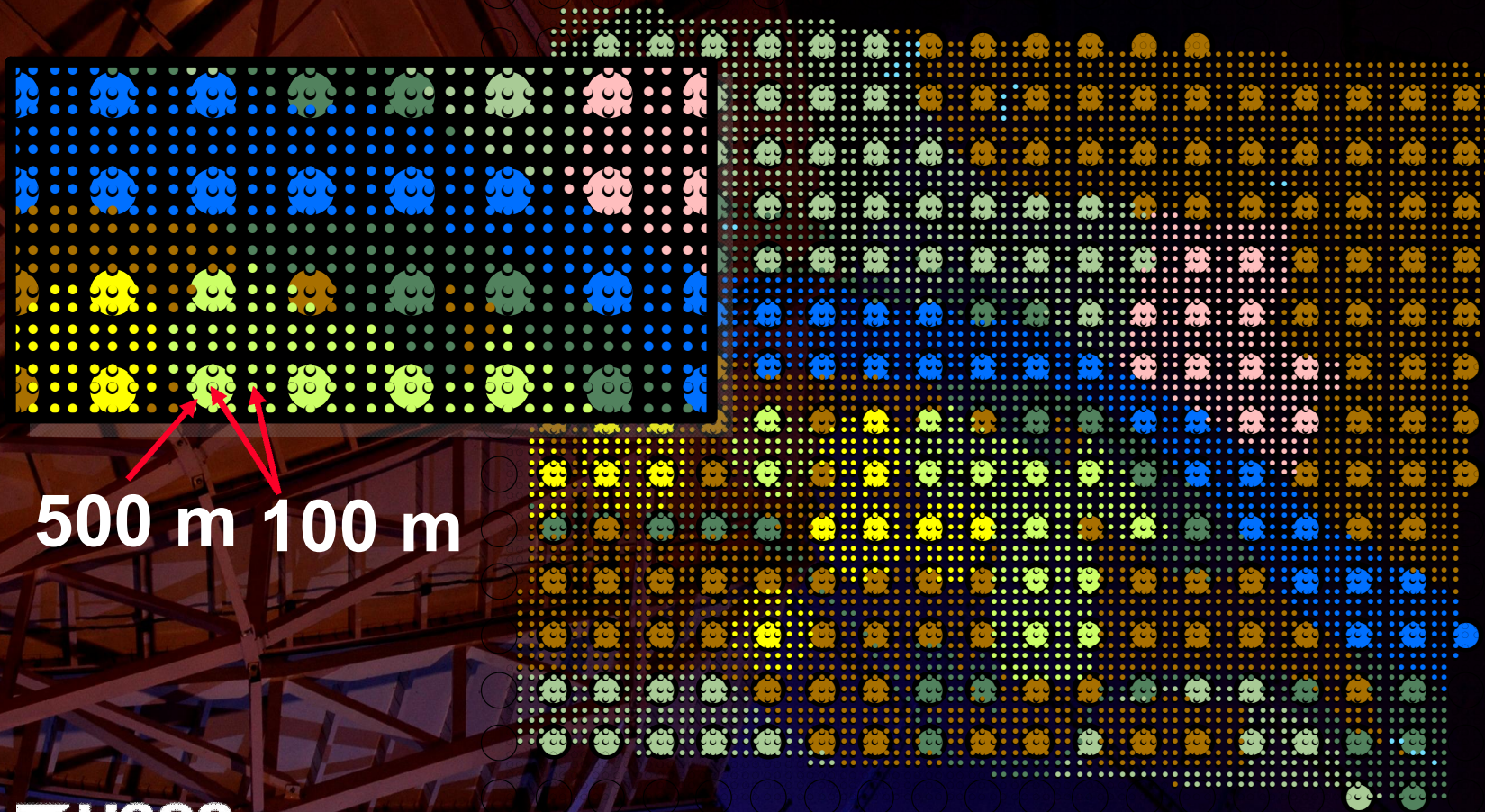
Nested datasets – 500 m and 250 m



500 m 250 m

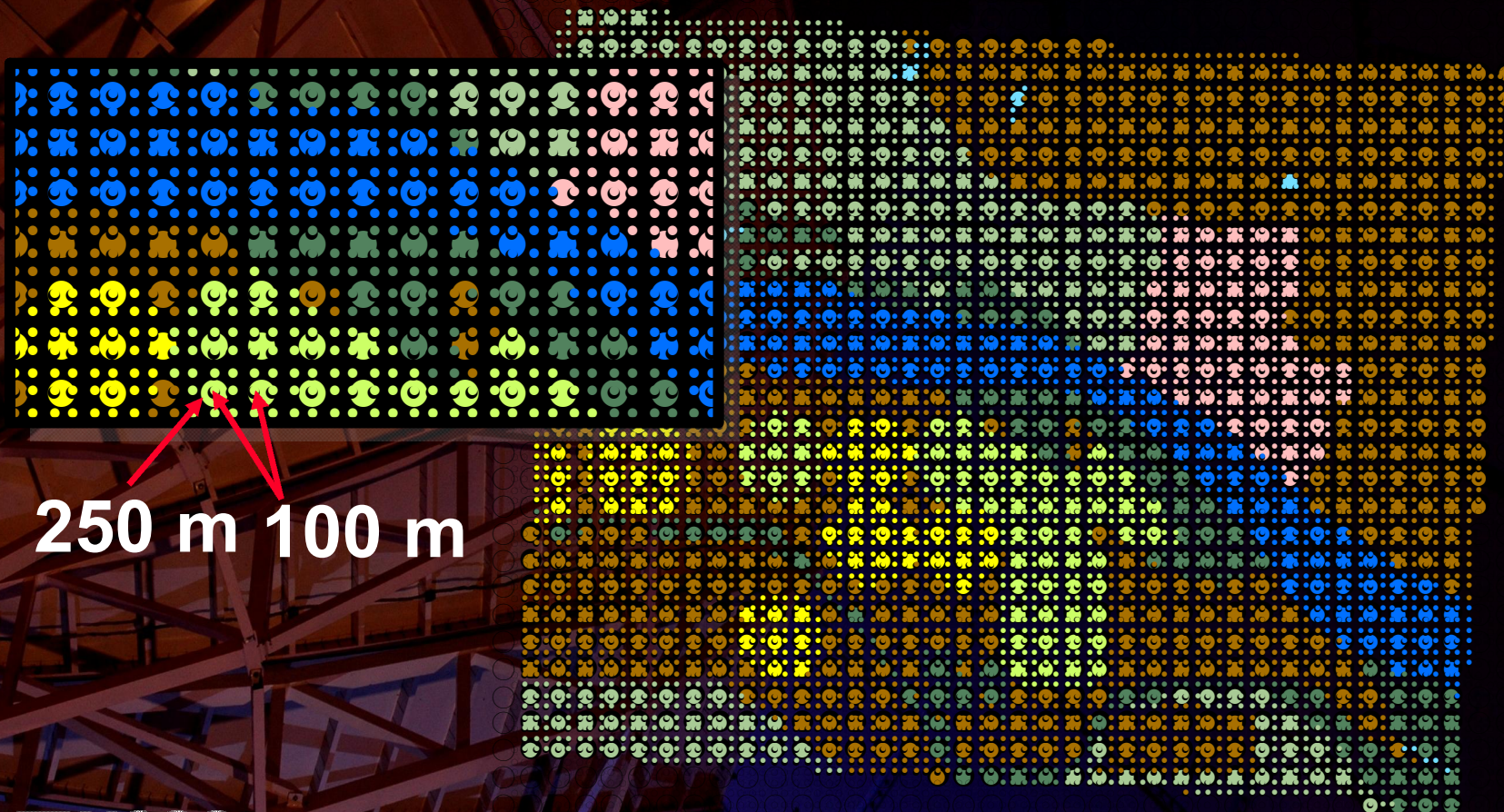
Product Development: RLCM Features

Nested datasets – 500 m and 100 m



Product Development: RLCM Features

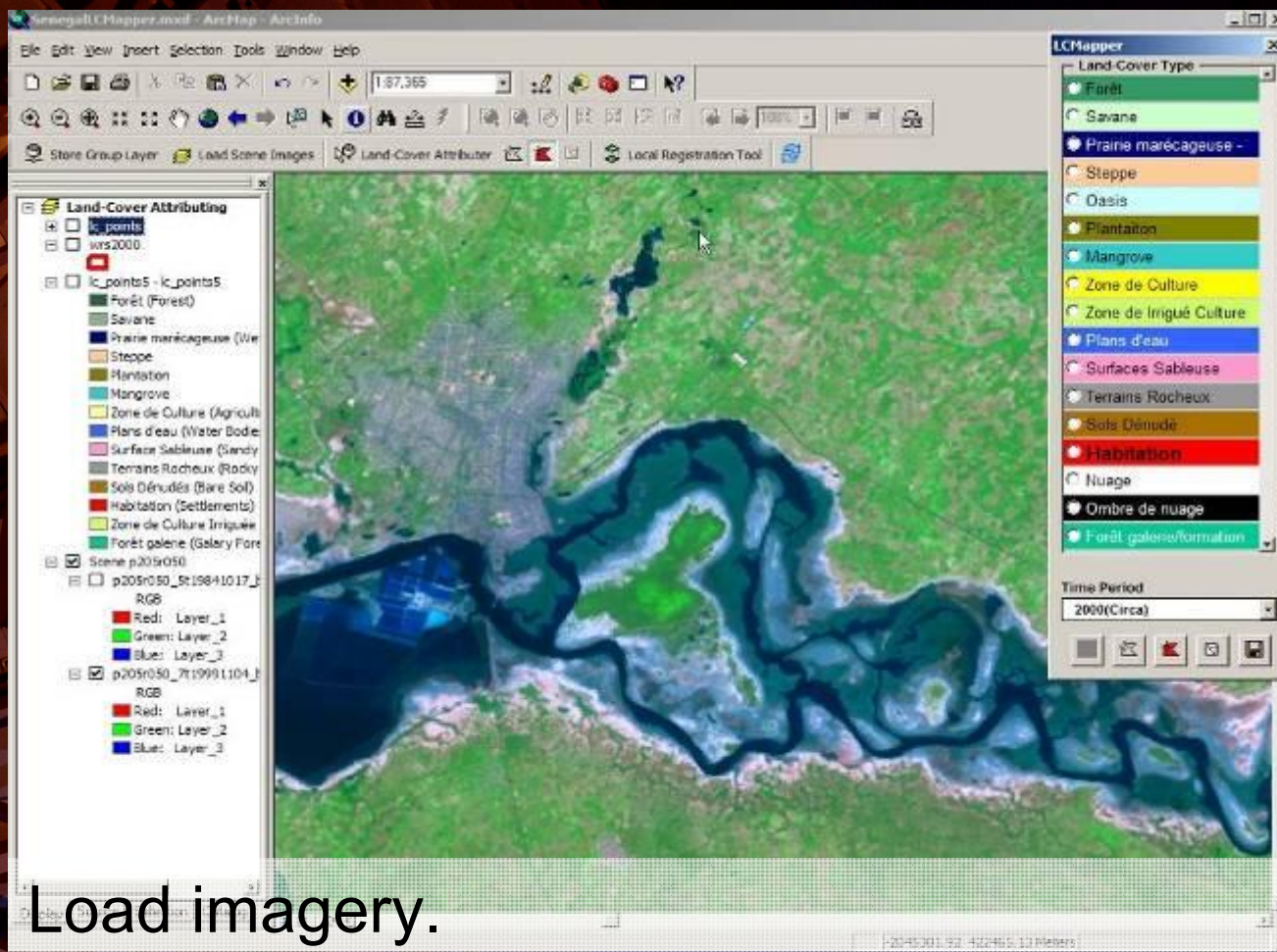
Nested datasets – 250 m and 100 m



RLCM

Product Development Workflow

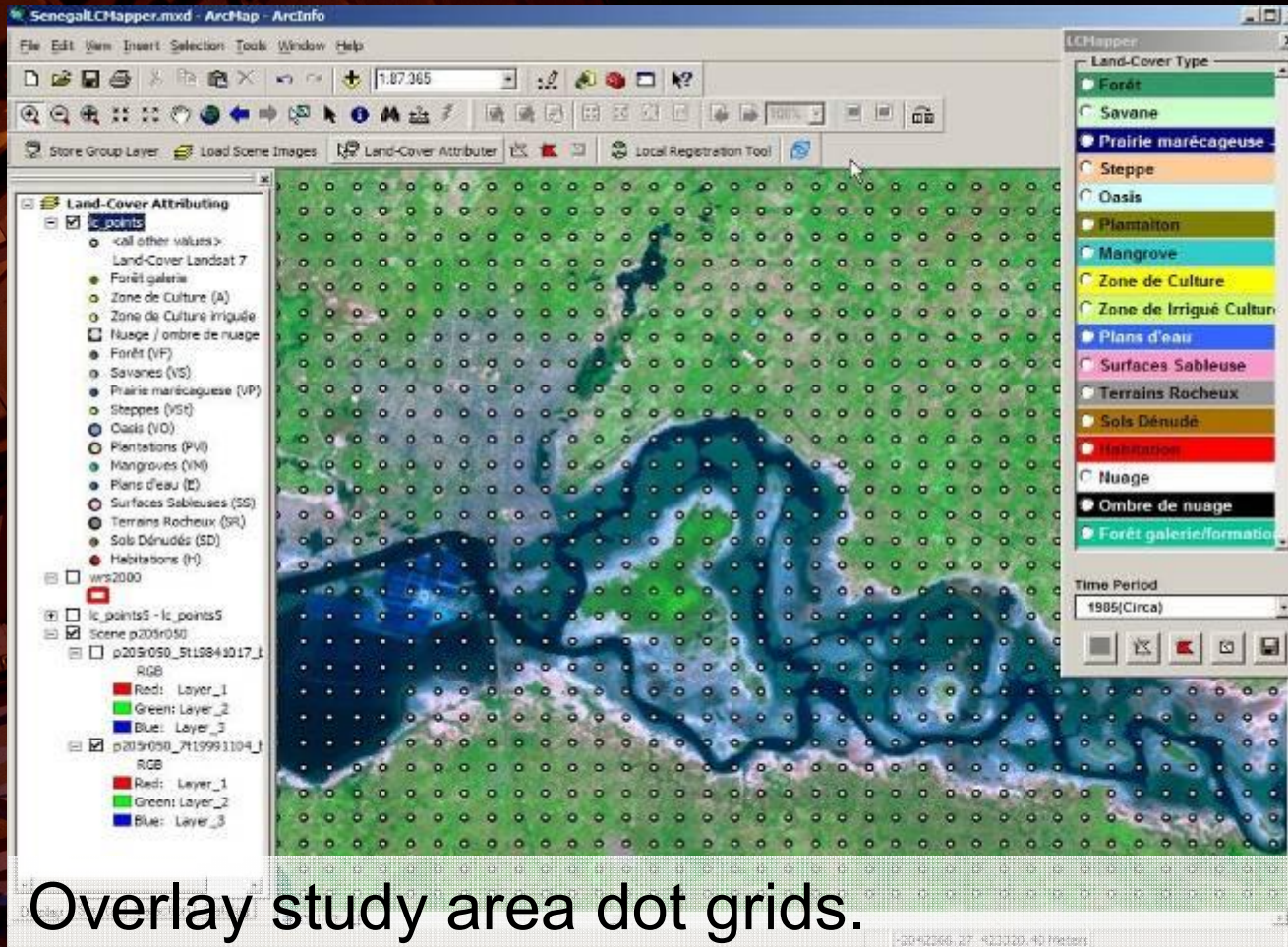
Product Development Workflow: Load Imagery



Load imagery.

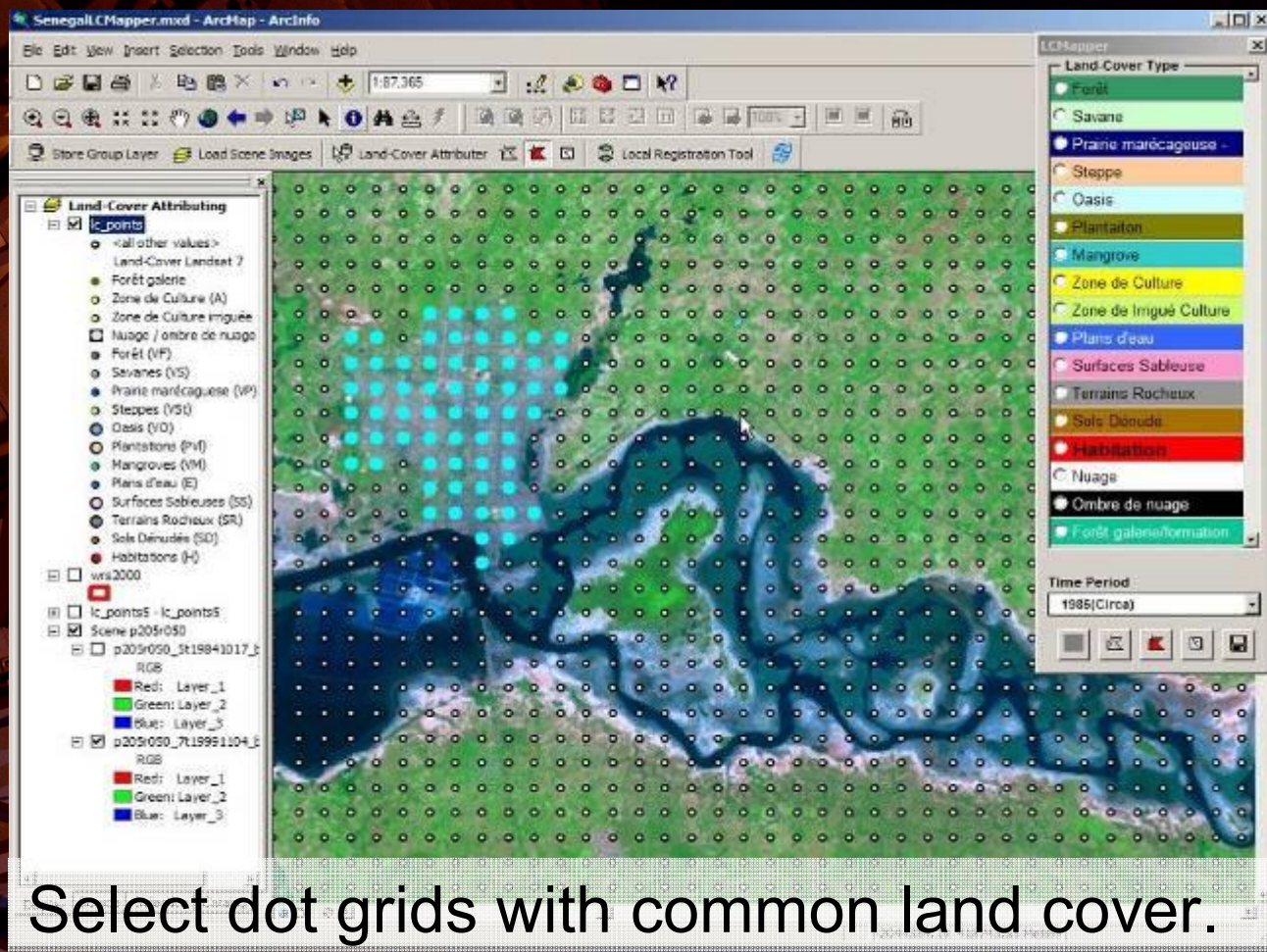
Source: USGS, 2007b

Product Development Workflow: Overlay



Source: USGS, 2007b

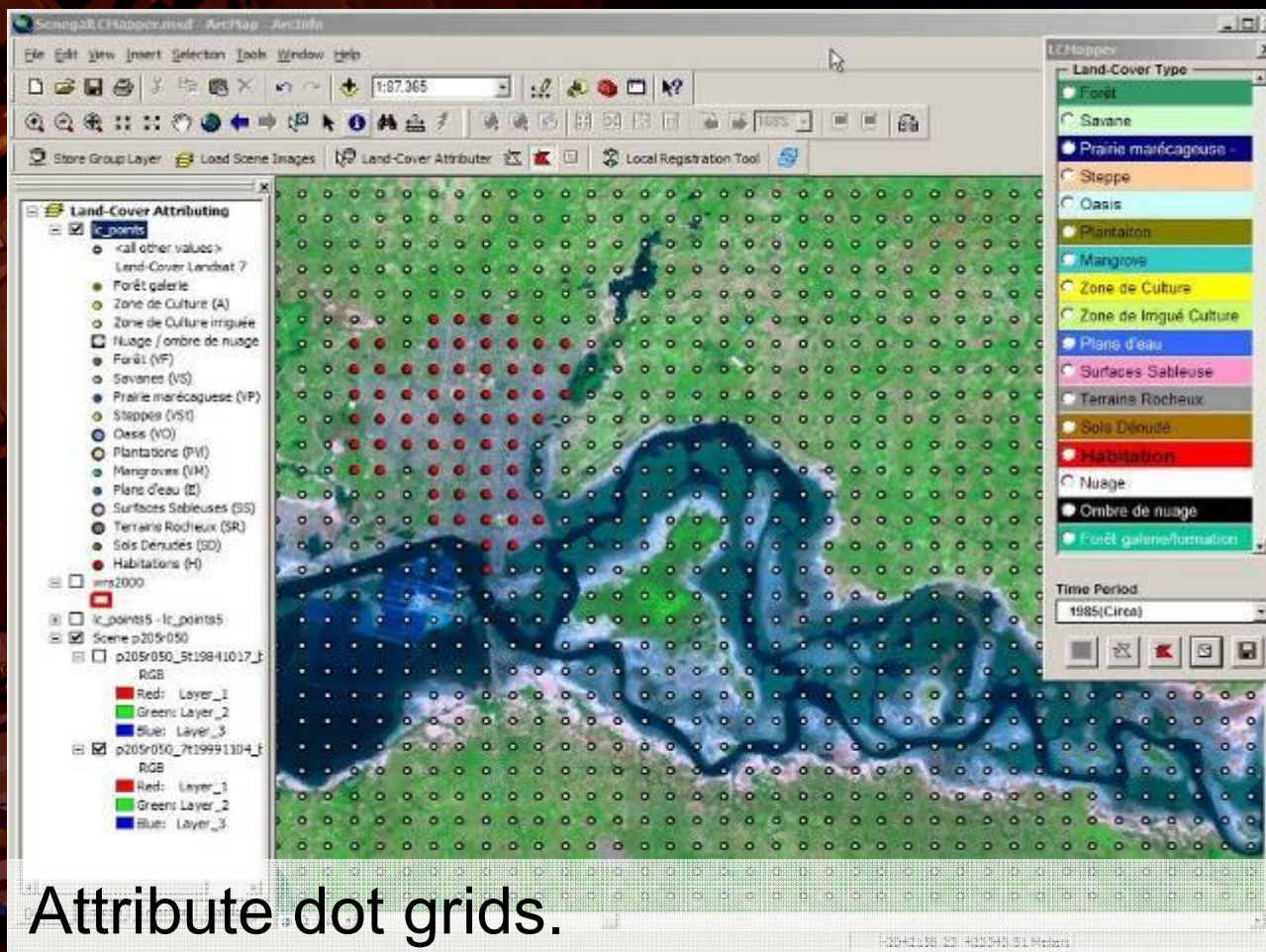
Product Development Workflow: Classifying



Select dot grids with common land cover.

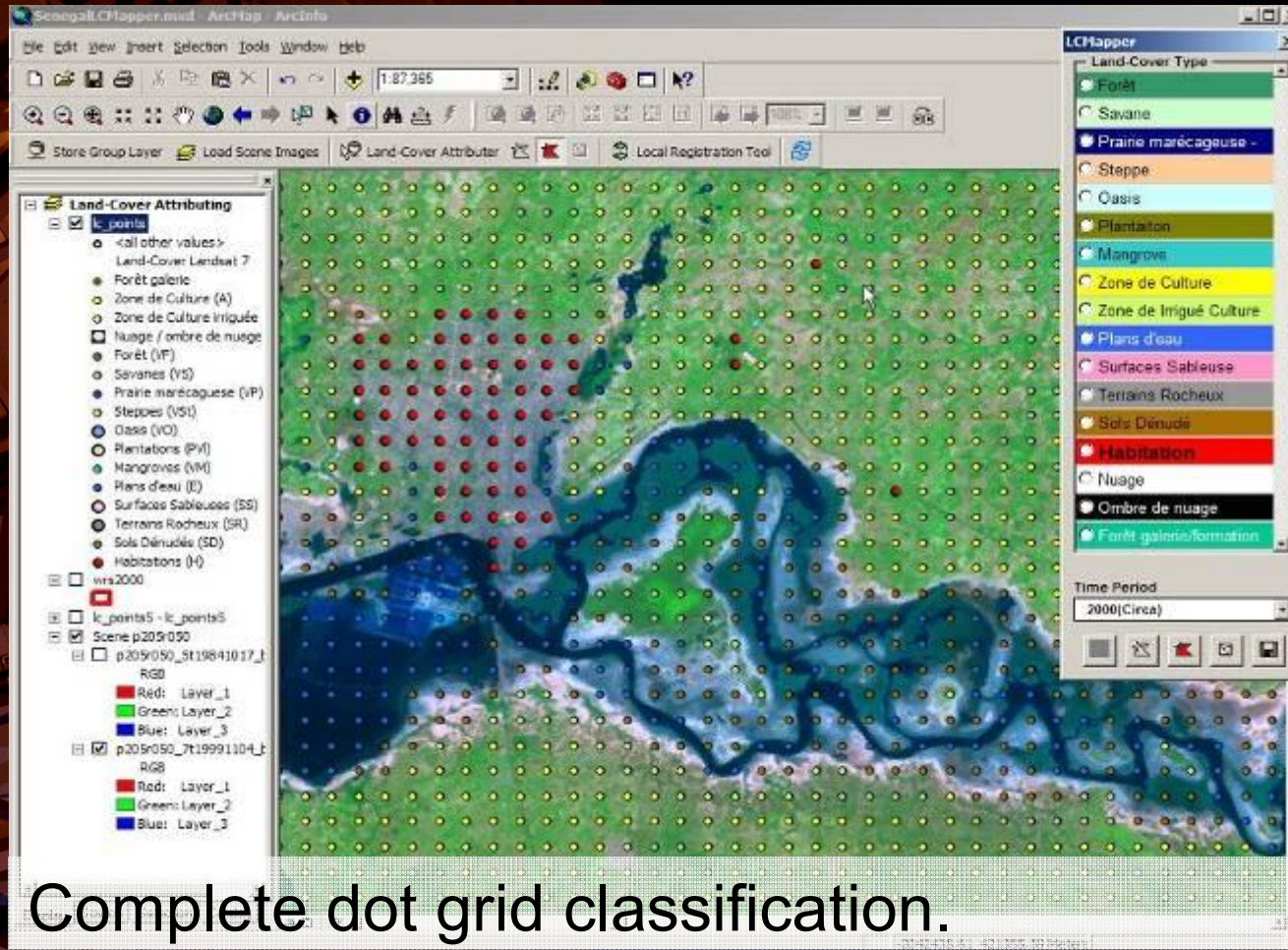
Source: USGS, 2007b

Product Development Workflow: Classifying



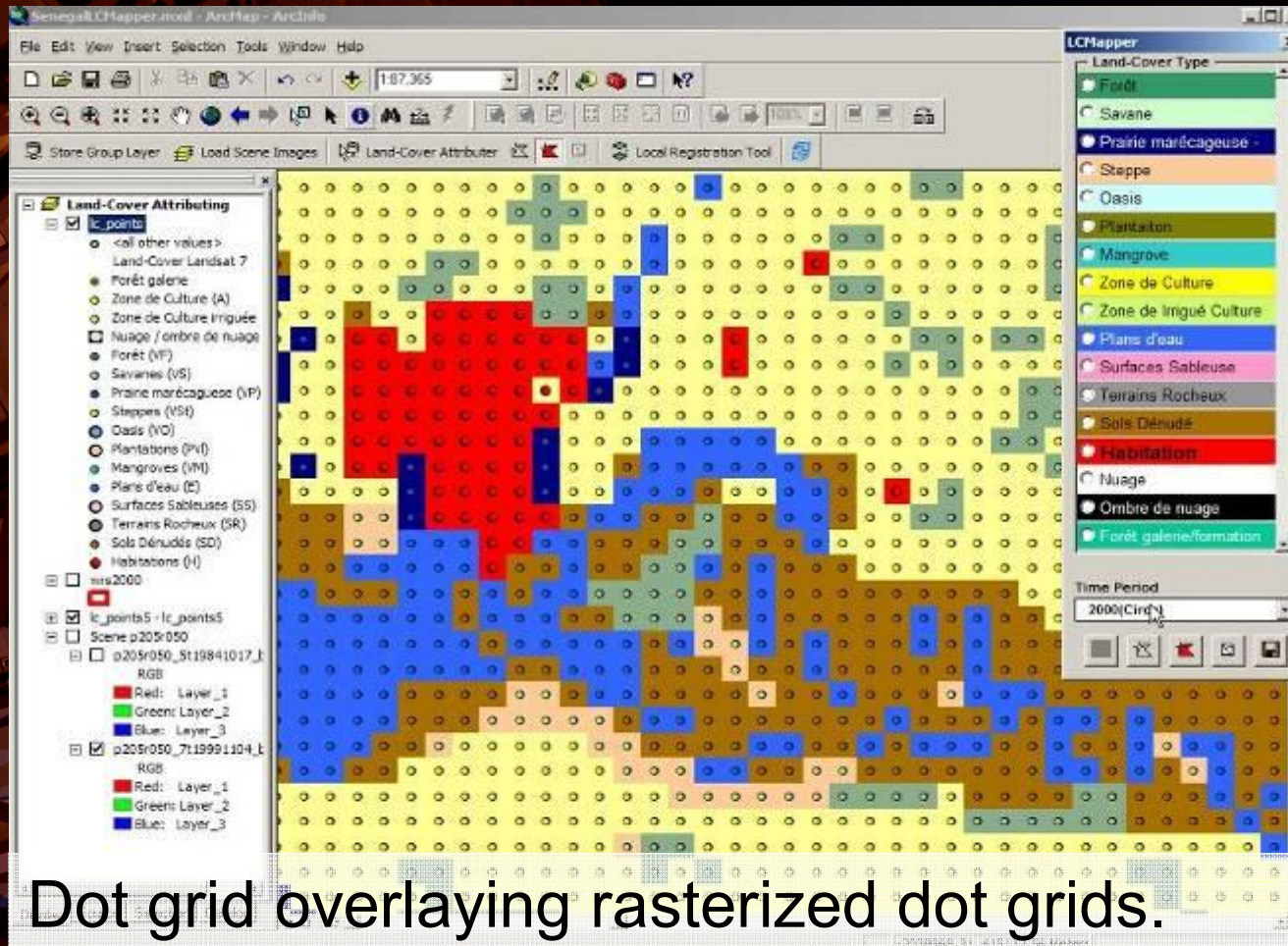
Source: USGS, 2007b

Product Development Workflow: Classifying



Source: USGS, 2007b

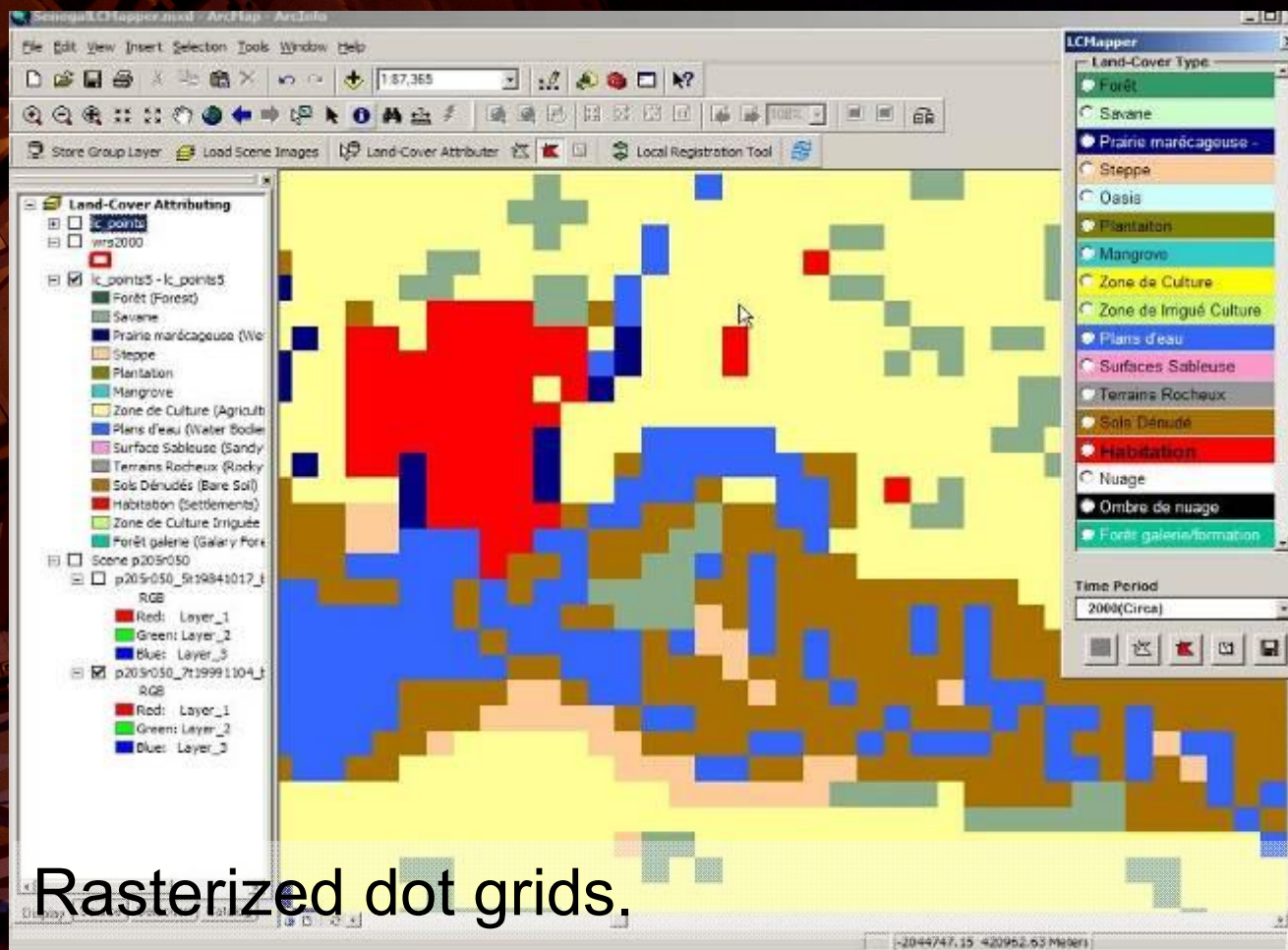
Product Development Workflow: Conversion



Dot grid overlaying rasterized dot grids.

Source: USGS, 2007b

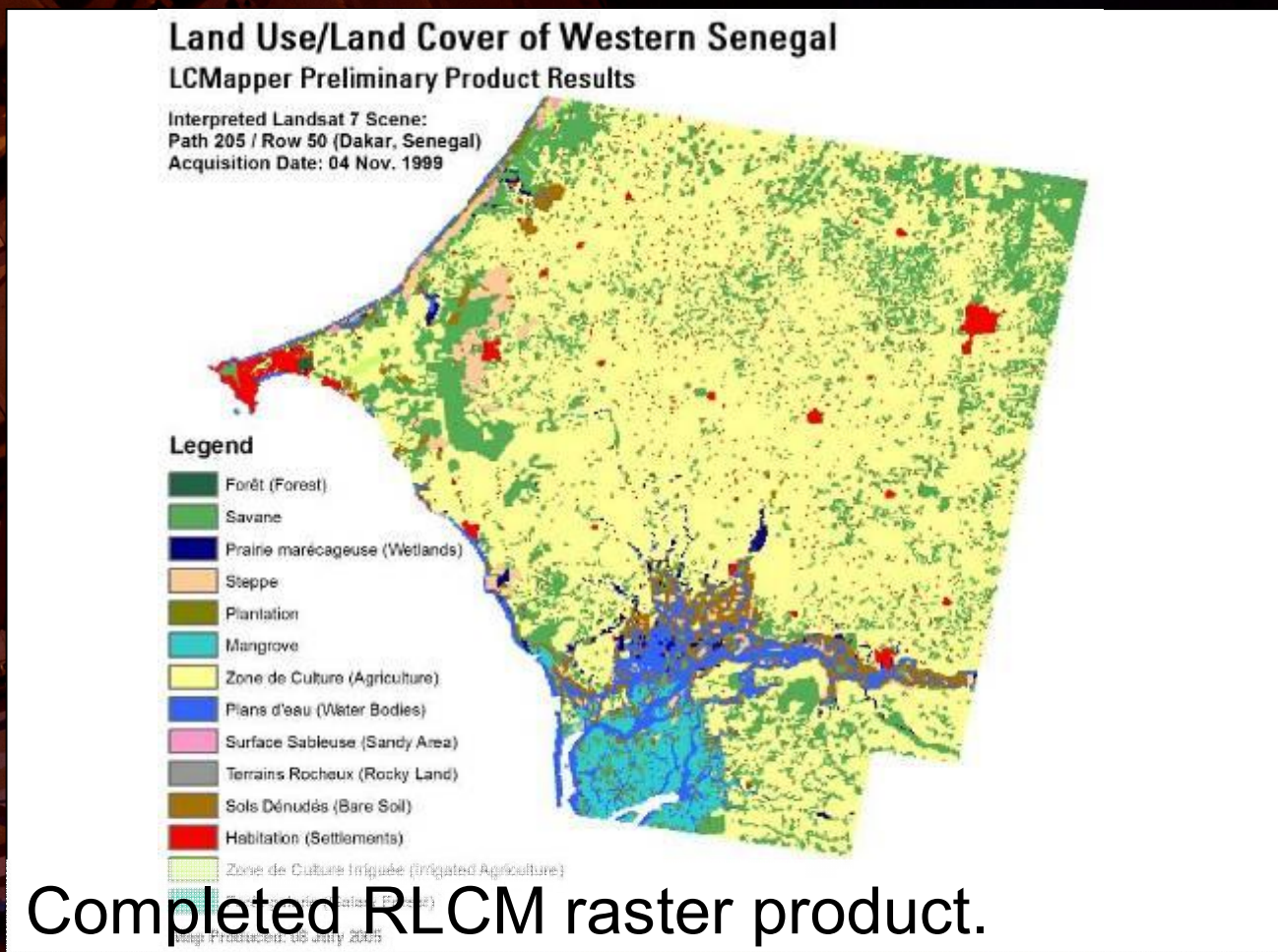
Product Development Workflow: Conversion



Rasterized dot grids.

Source: USGS, 2007b

Product Development Workflow: Conversion



Source: USGS, 2007b

Known Issues

- Land cover classification limitations
- Single study area project management
 - How to manage multiple study areas in a database
 - How to manage multiple study areas in a ArcMap project
- Performance issue with large datasets (>200K records)
- Needs some user interface enhancements:
 - Image Library Console, Attributer, and more

Enhancement Wish List

- Simple “Push Button” export of LULC for both vector and raster formats
 - Create better exported attribute table and allow user to select attributes to export.
 - Batch export – have user select time periods to export.
- Google Earth export or view option
- LULC harvester – if a valid raster LULC dataset exists for a time period, RLCM should be able to harvest the classification for all intersection dot grids.

References

- Gregorio A. D., Jansen L. J., 2000, Land Cover Classification System – LCCS – Classification Concepts and User Manual. Rome, Food and Agriculture Organization of the United Nations. p 41.
- U.S. Geological Survey (USGS), 2007a, *Rapid Land Cover Mapper (RCLM)* [online], Available: <http://edcintl.cr.usgs.gov/rbcm> [accessed 30 October 2007]
- U.S. Geological Survey (USGS), 2007b, *The West Africa Land Use and Land Cover Trends Project*, U.S. Geological Survey Fact Sheet 2007-2947.

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