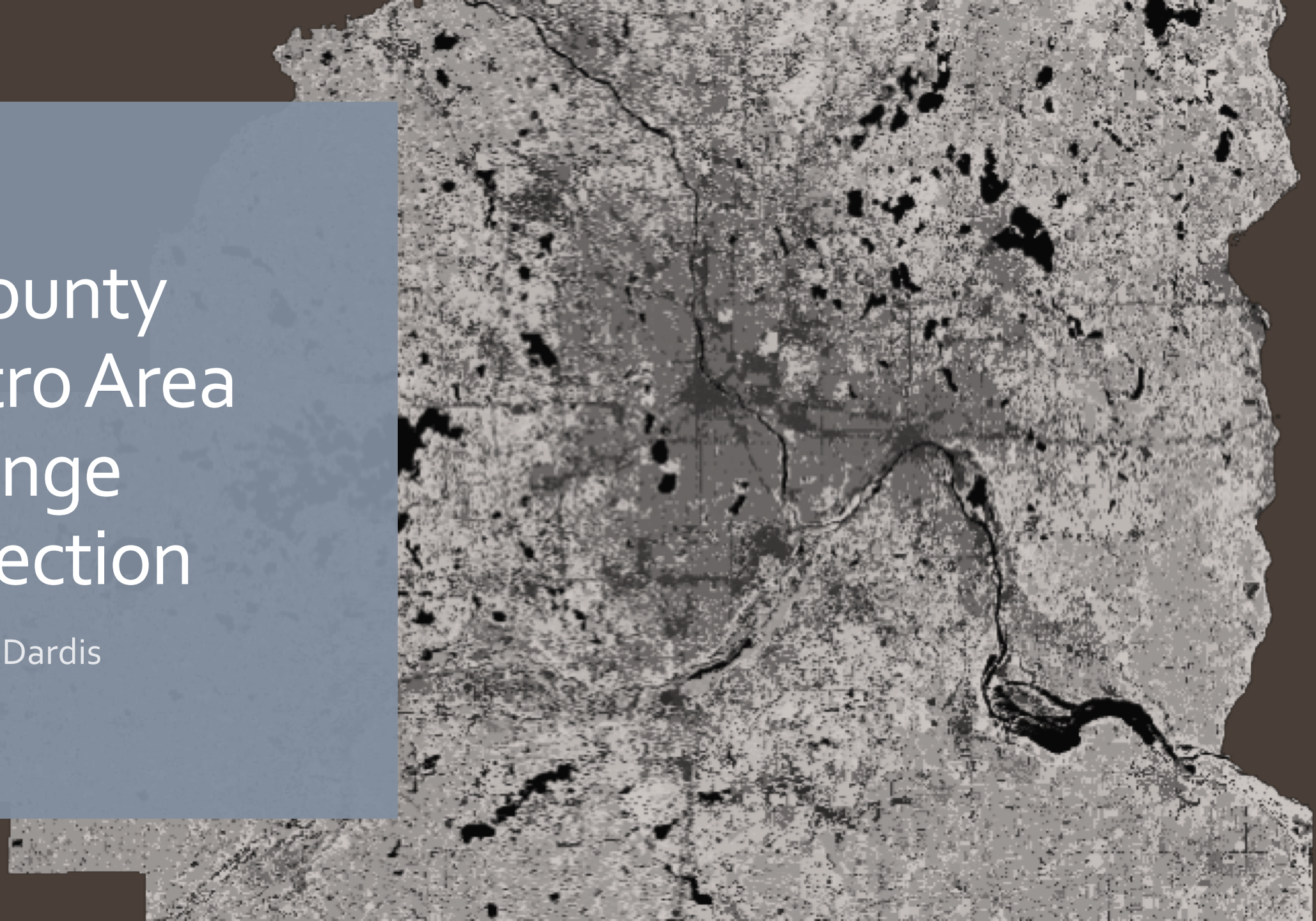
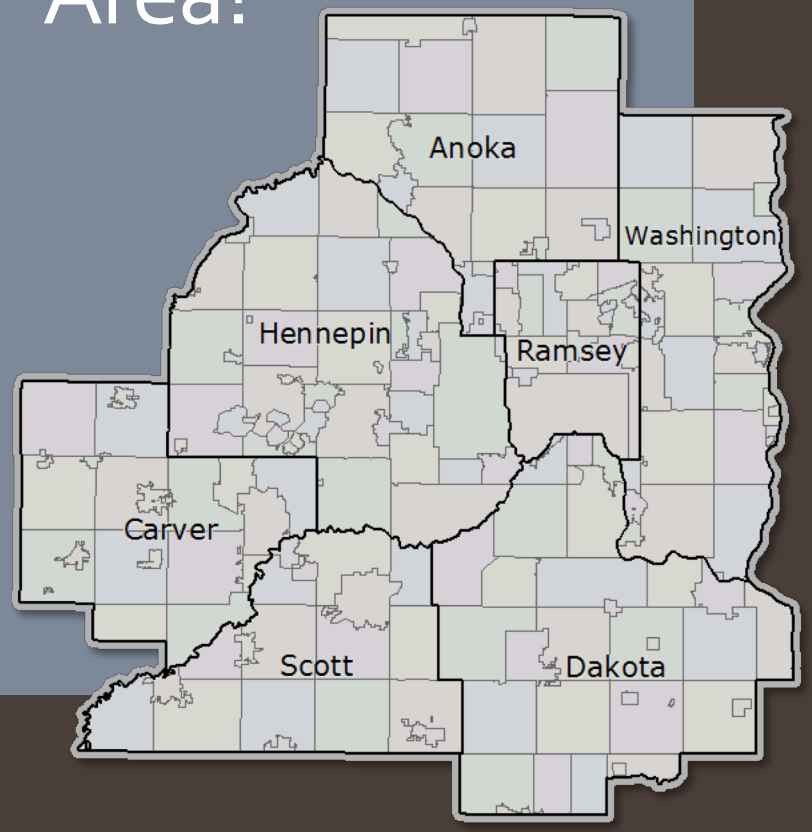
7-County Metro Area Change Detection

By Tyler Dardis



What's the 7-County Metro Area?



- Counties that contain, and surround the Twin Cities
  - Today, comprise approx. 3.5 million people, over half the state's population
- Includes:
  - Anoka
  - Hennepin (Minneapolis)
  - Ramsey (St. Paul)
  - Washington
  - Dakota
  - Scott
  - Carver

What's the Question?

- Answer the question of when and where the 7-Country Metro Area has expanded between 1975 and 2015.

Why?

- Urban Growth can have many effects on the environment, destroying ecosystems, and much more
- To answer the question if the metro area is doing urban revitalization (urban renovation, keeping within limits), or rampantly expanding and sprawling away from the core.

How?

- Take remotely sensed imagery, and **classify** it into Urban, and Non-Urban areas. You can then see where change has occurred through change detection mapping.
  - You can also get area data to see change in numbers.

Data Used

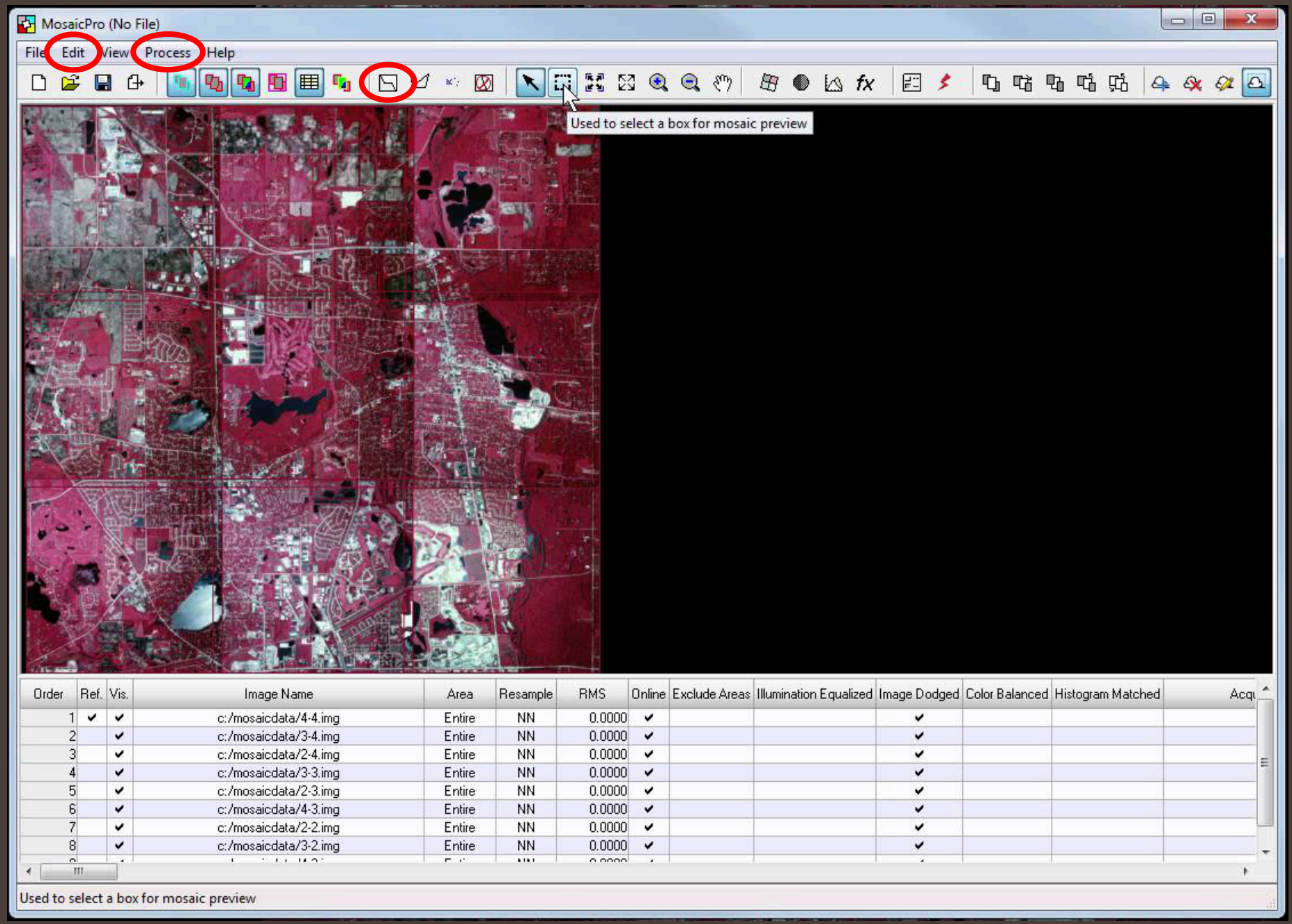
- All Landsat Data from USGS's GloVis
  - 1975 – Landsat 1 (July 29th)
  - 1985 – Landsat 5 (April 28th)
  - 1995 – Landsat 5 (July 13th)
  - 2005 – Landsat 5 (June 22nd)
  - 2015 – Landsat 8 (March 14th)
- MN Statewide Country Shapefile from MNDOT GIS Data
  - Used to create 7-country metro AOI

Need to Pre-Process the Data

- Start with Stacking Bands into one image
  - Under Raster -> Spectral -> Layer Stack
- Stacked bands 4-7 for LS1
- Stacked bands 1-7 for LS5 and LS8
  - Saved all as one single .img

Mosaicking

- 1985-2005 didn't have just one Landsat cover the 7-county area
  - Needed 2 Landsat images, and mosaic them together
  - Once the both images are stacked, we simply open MosaicPro
    - Raster -> Mosaic -> MosaicPro
  - Added both images
  - Changed Seamline to Weighted (blends together)
  - Ran the Process
    - Saved both images, mosaiced together, as one .img file

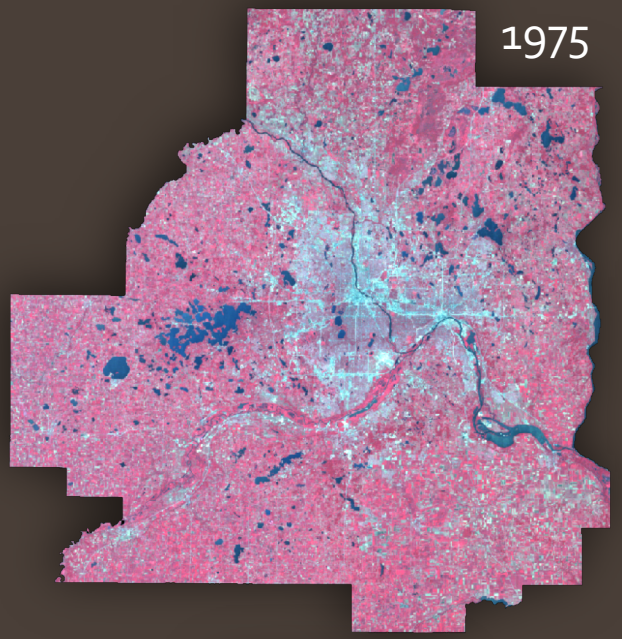

MosaicPro (No File)
File
Edit
View
Process
Help
Used to select a box for mosaic preview
Order
Ref.
Vis.
Image Name
Area
Resample
RMS
Online
Exclude Areas
Illumination Equalized
Image Dodged
Color Balanced
Histogram Matched
1 c:/mosaicdata/4-4.img Entire NN 0.0000
2 c:/mosaicdata/3-4.img Entire NN 0.0000
3 c:/mosaicdata/2-4.img Entire NN 0.0000
4 c:/mosaicdata/3-3.img Entire NN 0.0000
5 c:/mosaicdata/2-3.img Entire NN 0.0000
6 c:/mosaicdata/4-3.img Entire NN 0.0000
7 c:/mosaicdata/2-2.img Entire NN 0.0000
8 c:/mosaicdata/3-2.img Entire NN 0.0000
Used to select a box for mosaic preview

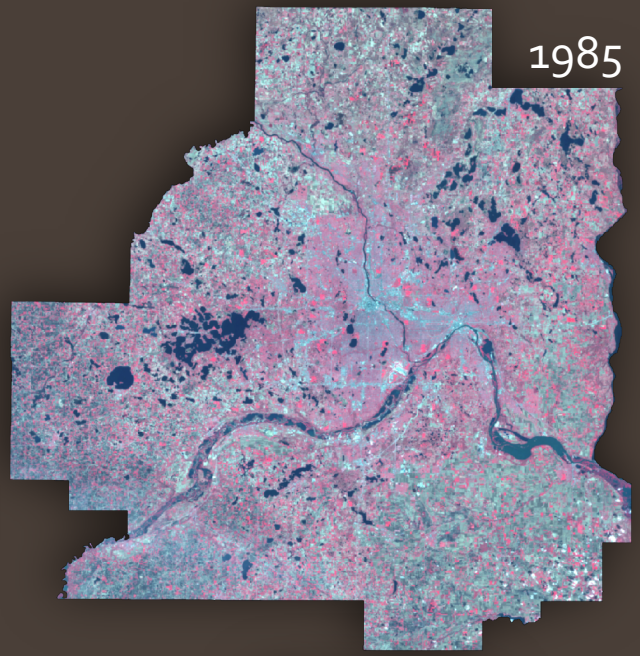
Clipping it Down

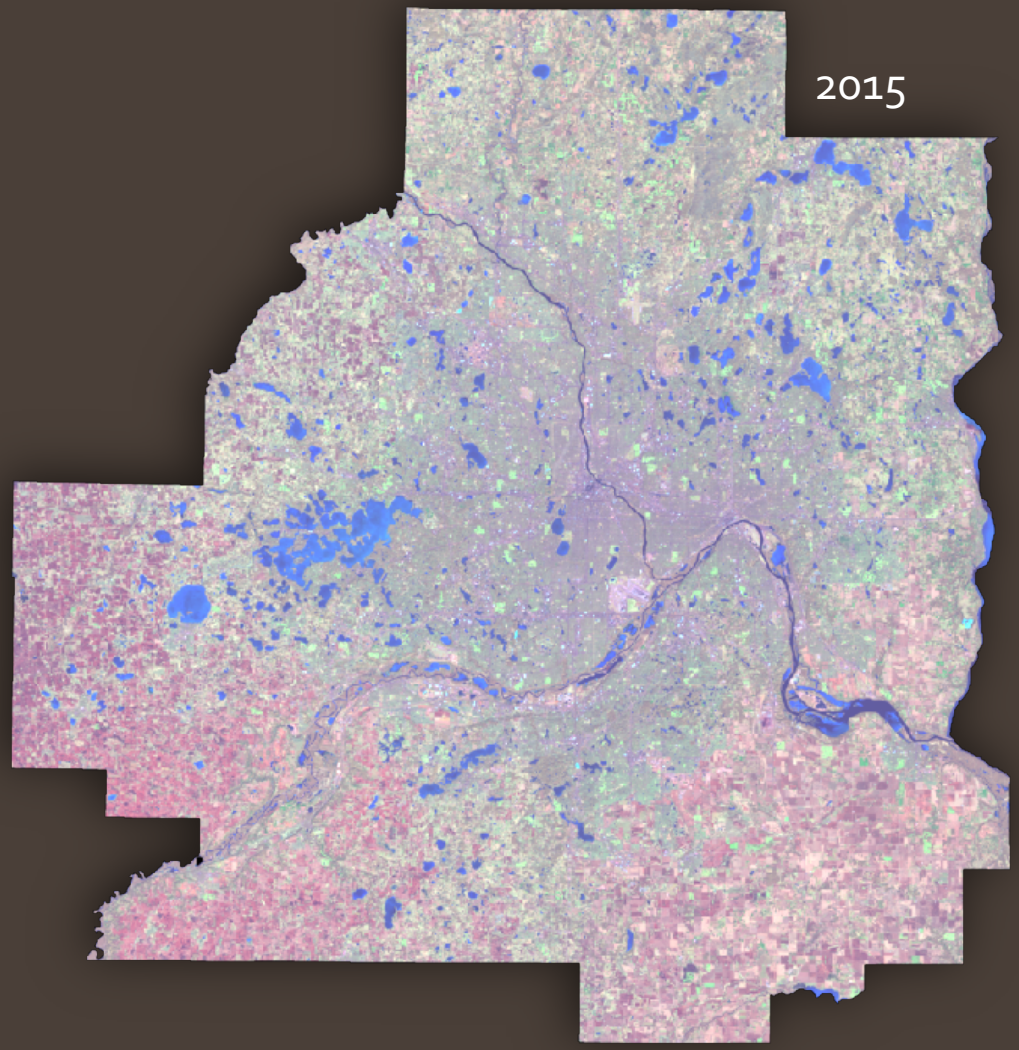
- Landsat Imagery covers a large area; only need 7-county area
  - Imported MNDOT's statewide county vector shapefile
  - Selected the 7 counties desired
  - With the counties selected, under the Vector Drawing tab, click Paste from Selected Object
    - This makes an AOI over the selected vector

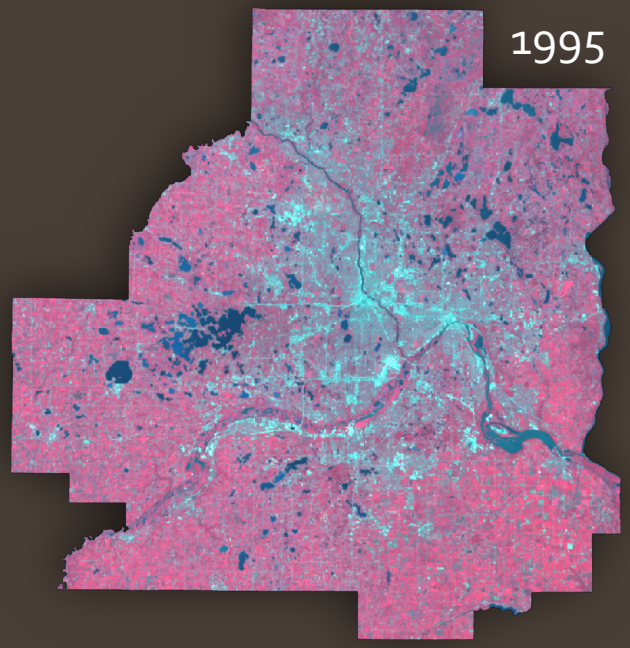
Clipping it Down Continued

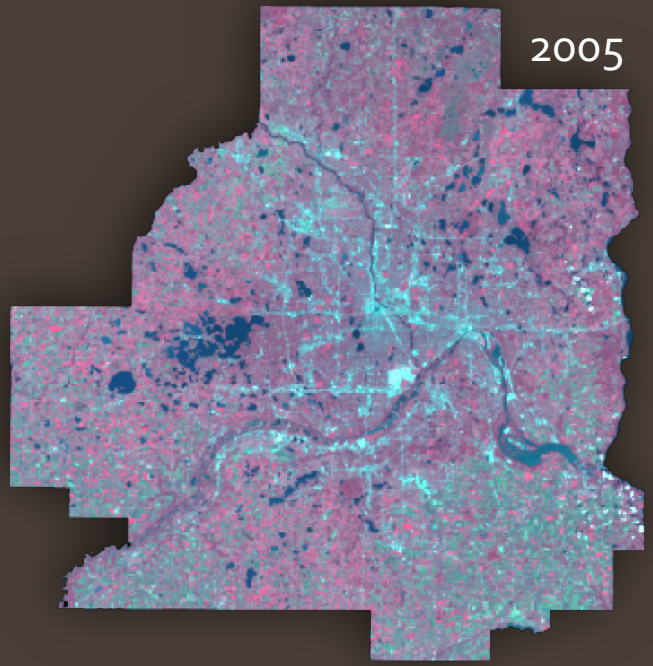
- With the 7-county AOI, we can begin the clipping process (called Subset)
  - Raster -> Subset & Chip -> Subset
- Selected input as the Landsat image, or mosaiced image
- Output as '_clipped'
- Click AOI
  - Select 7-county AOI


1975


1985


2015


1995

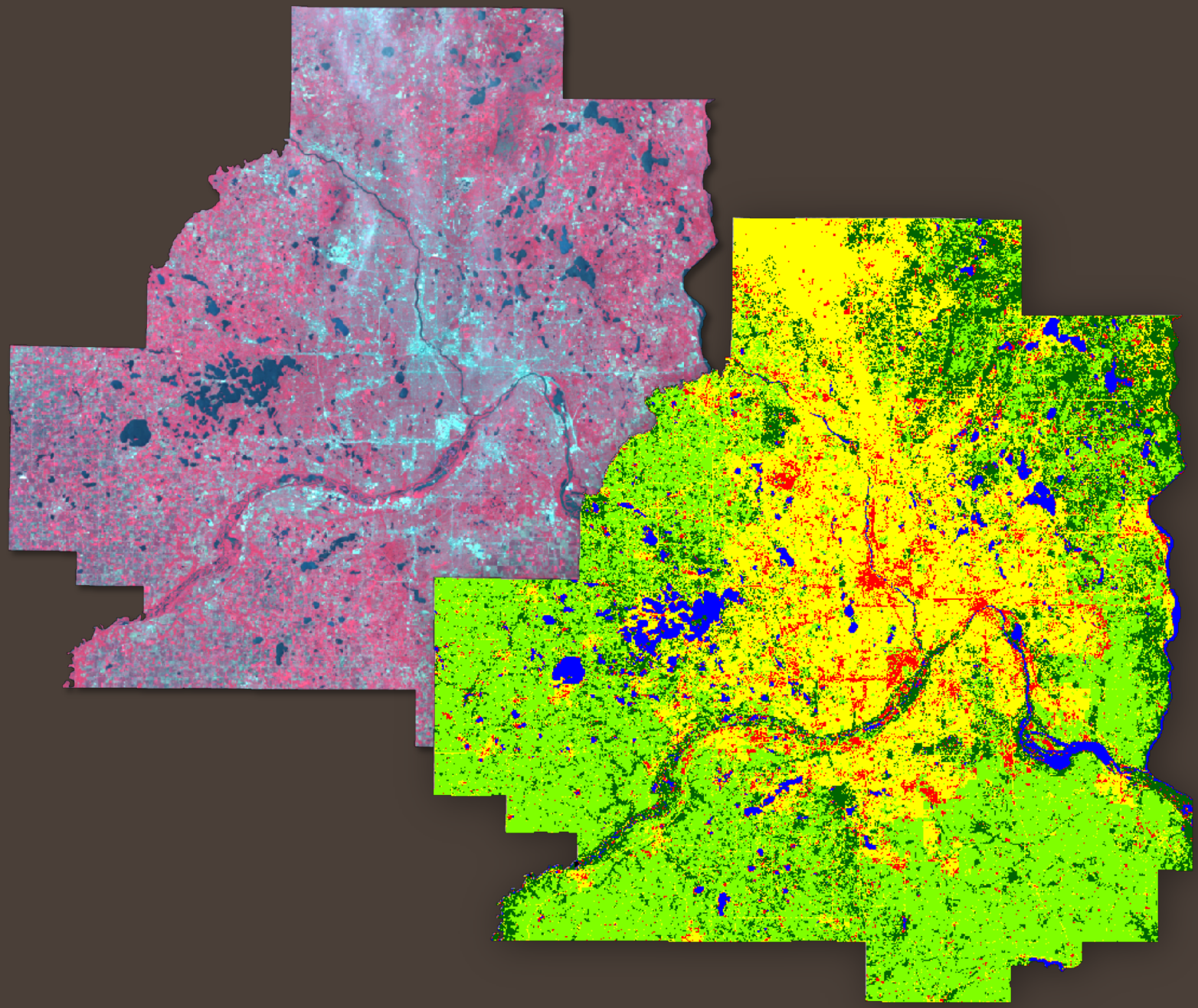

2005

Haze Reduction if Needed

- Haze reduction can help remove distortions in imagery due to fog, cloudy haze.
  - In my case, major areas were misclassified
  - Ended up finding new Landsat imagery for the most accuracy

Here's Why…

Northwest corner of Anoka county misclassified to suburban due to thin haze.



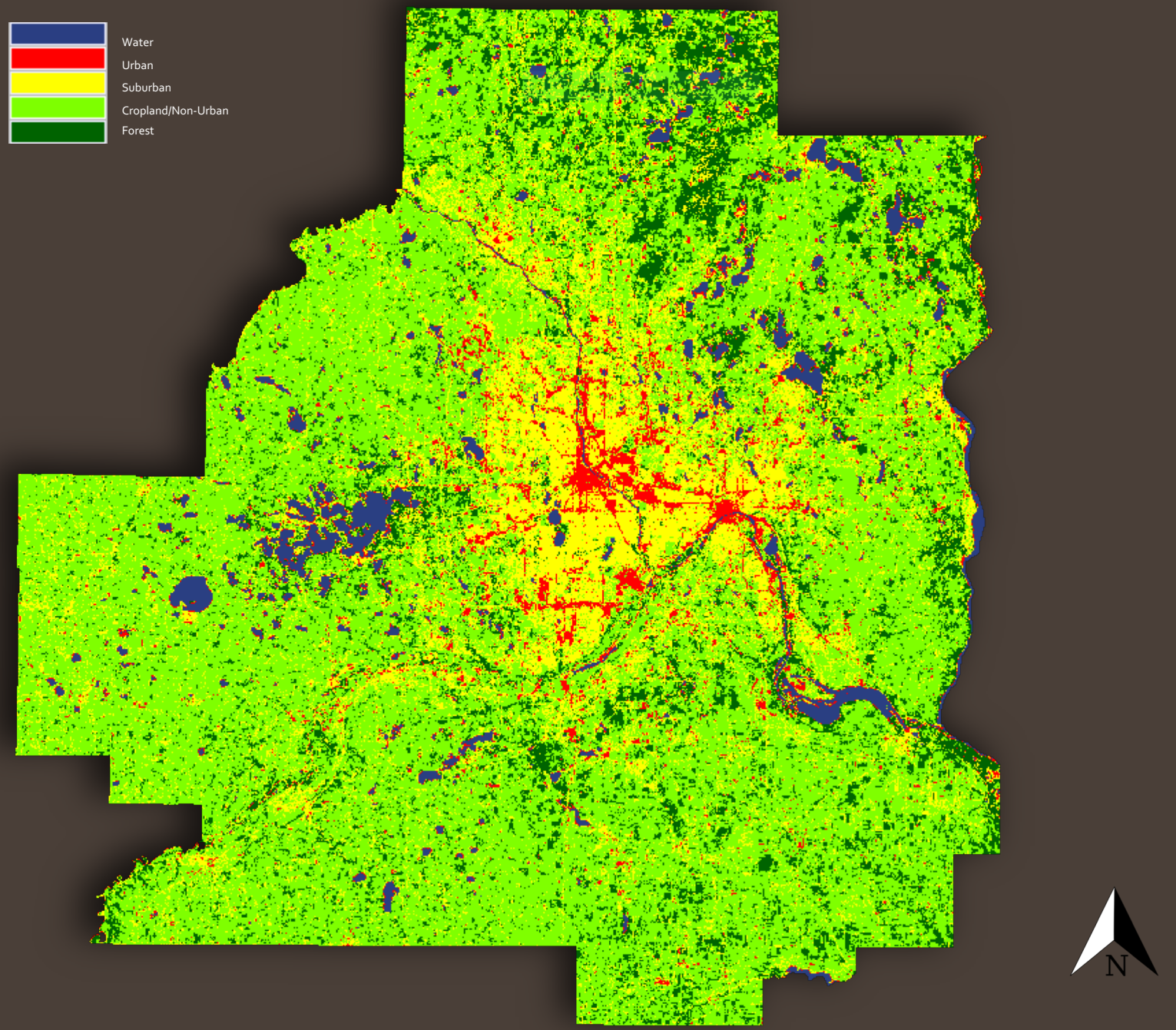
Classification Scheme Used

- Supervised Classification
  - Classified into **Water, Urban, Suburban, Cropland/Non-Urban, and Forest** area
    - Values started at 1, ended at 5
  - Used **8** training polygons per class, per image

1975 Classification

Urban + Suburban Acreage =

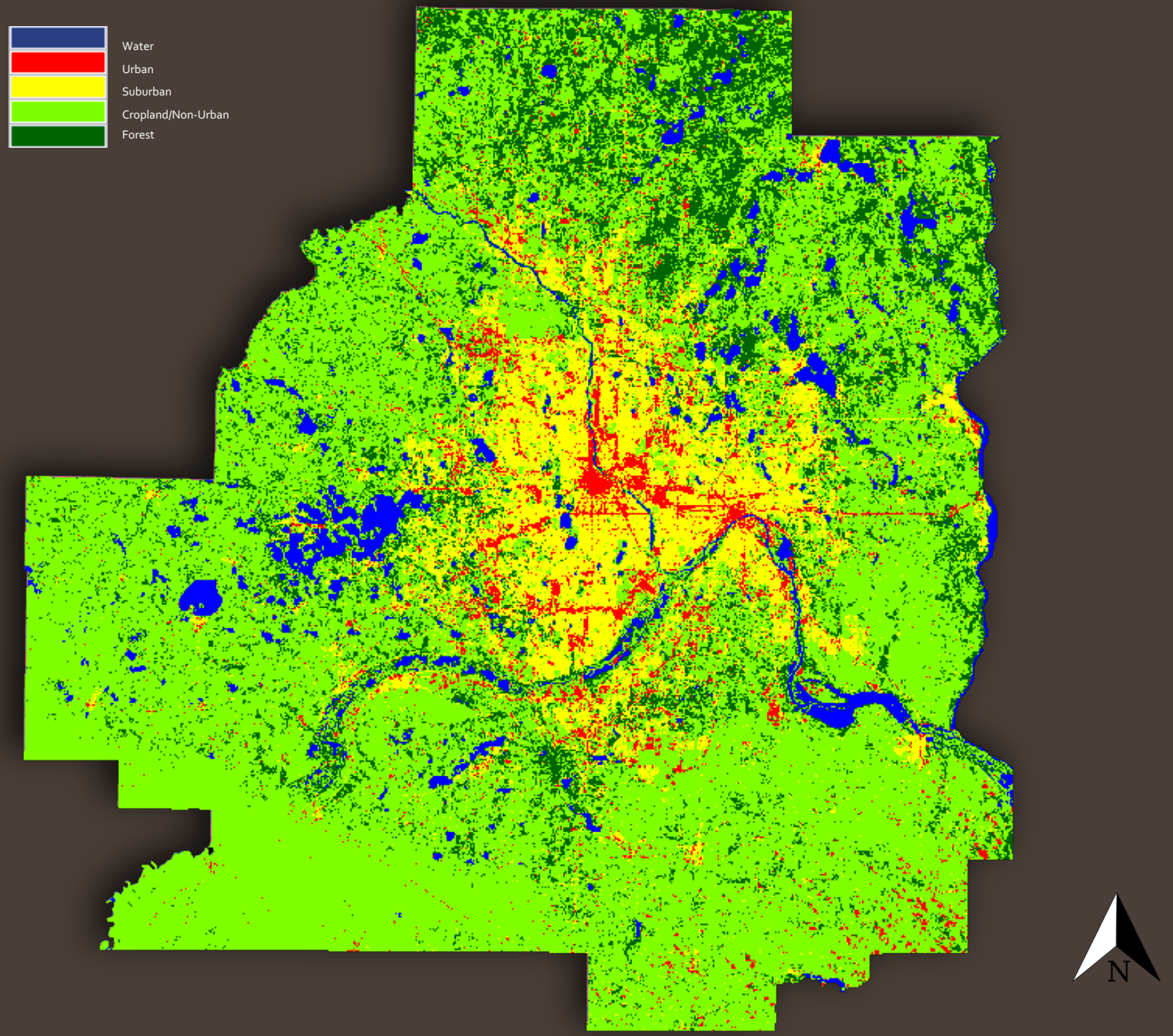
450,412



1985 Classification

Urban + Suburban Acreage =

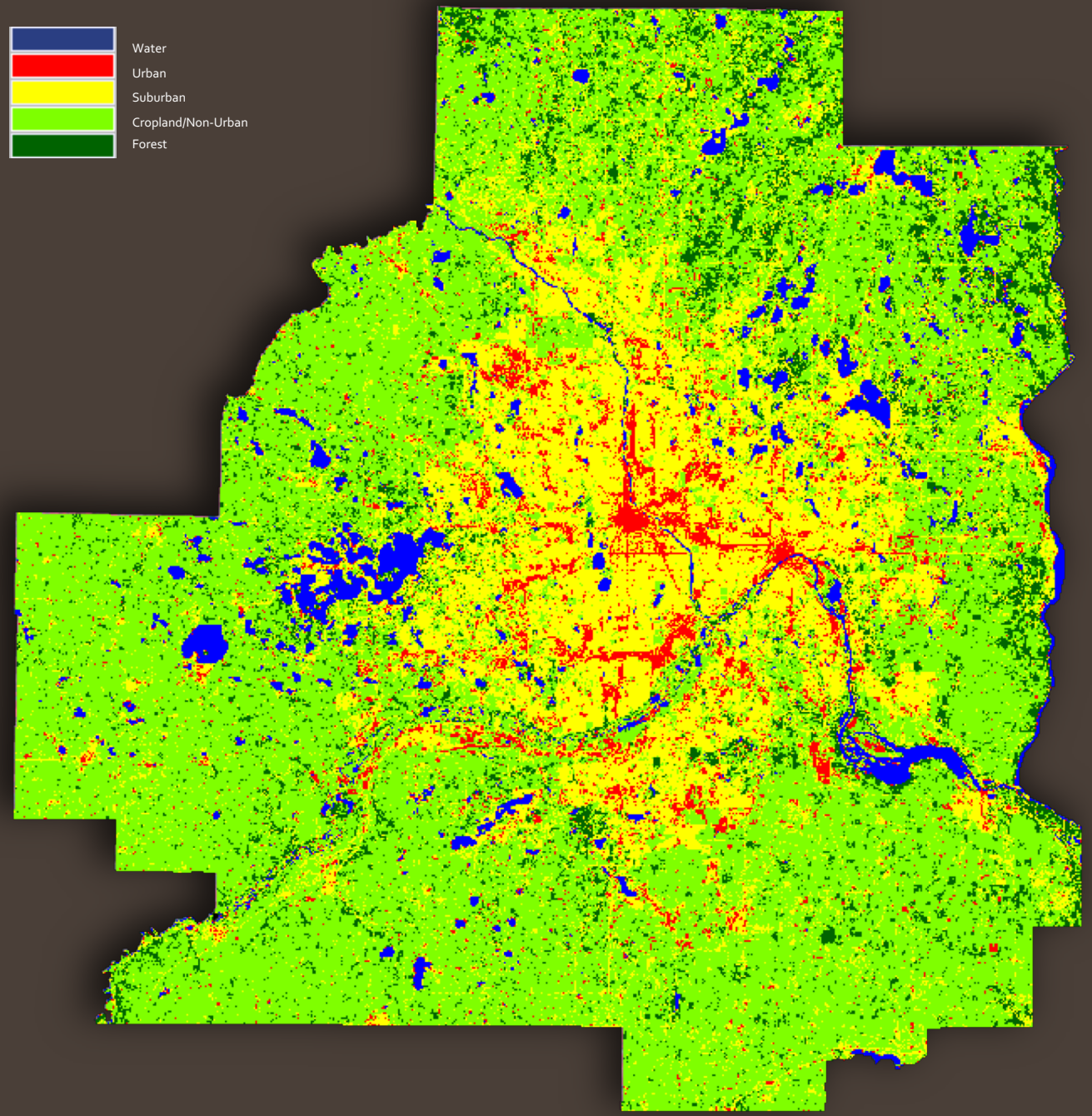
322,824



1995 Classification

Urban + Suburban Acreage =

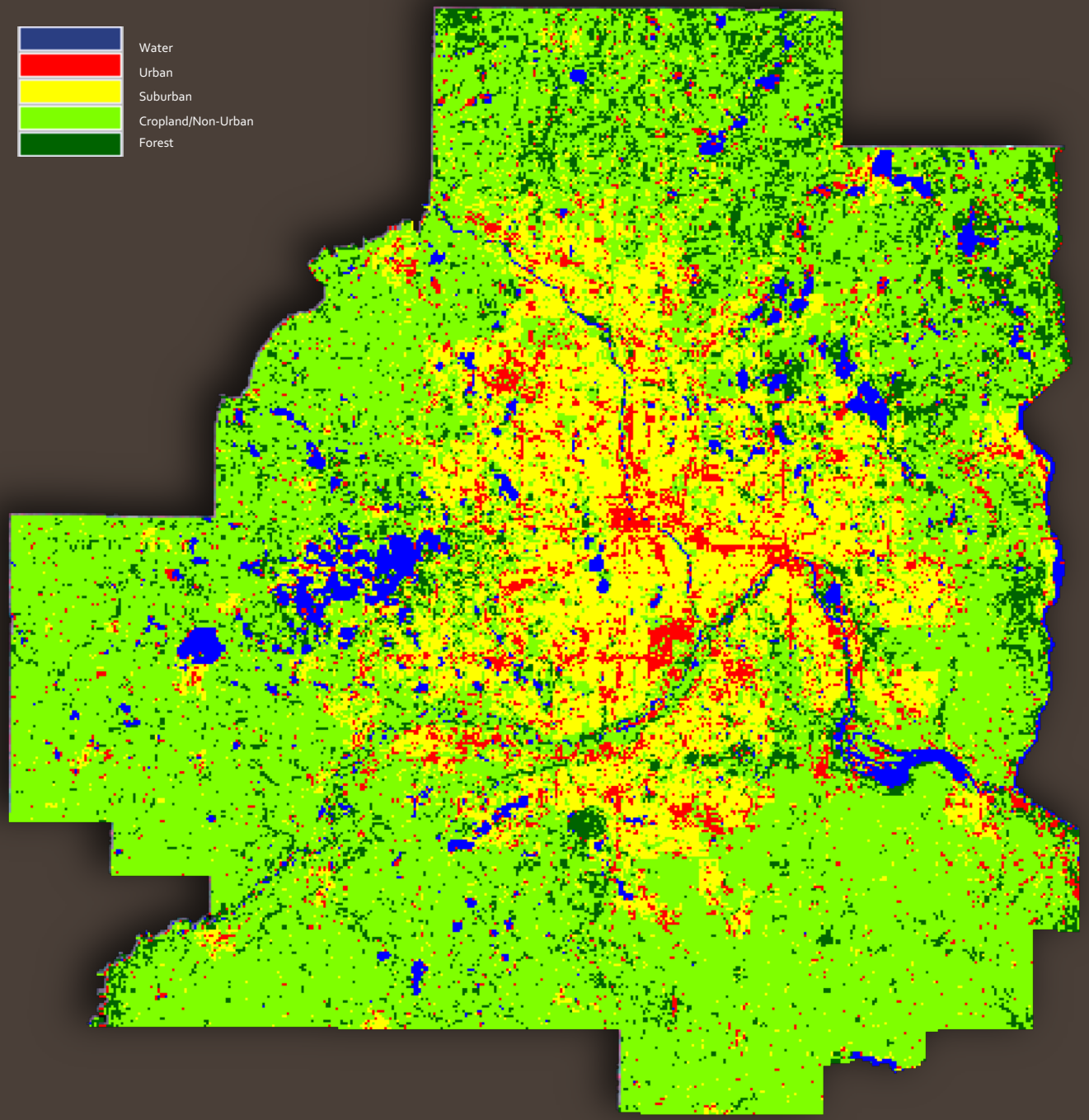
589,393



2005 Classification

Urban + Suburban Acreage =

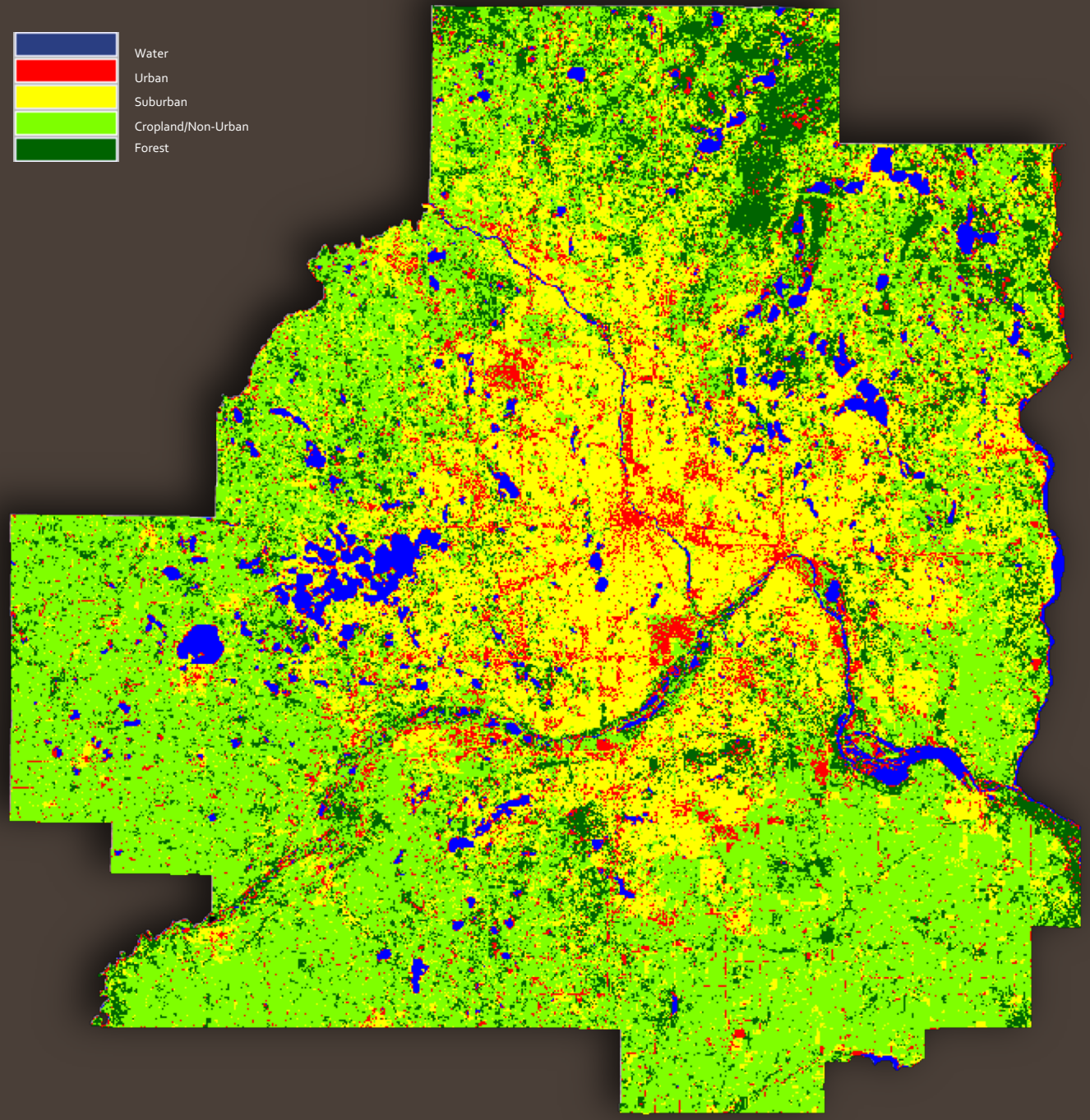
481,067

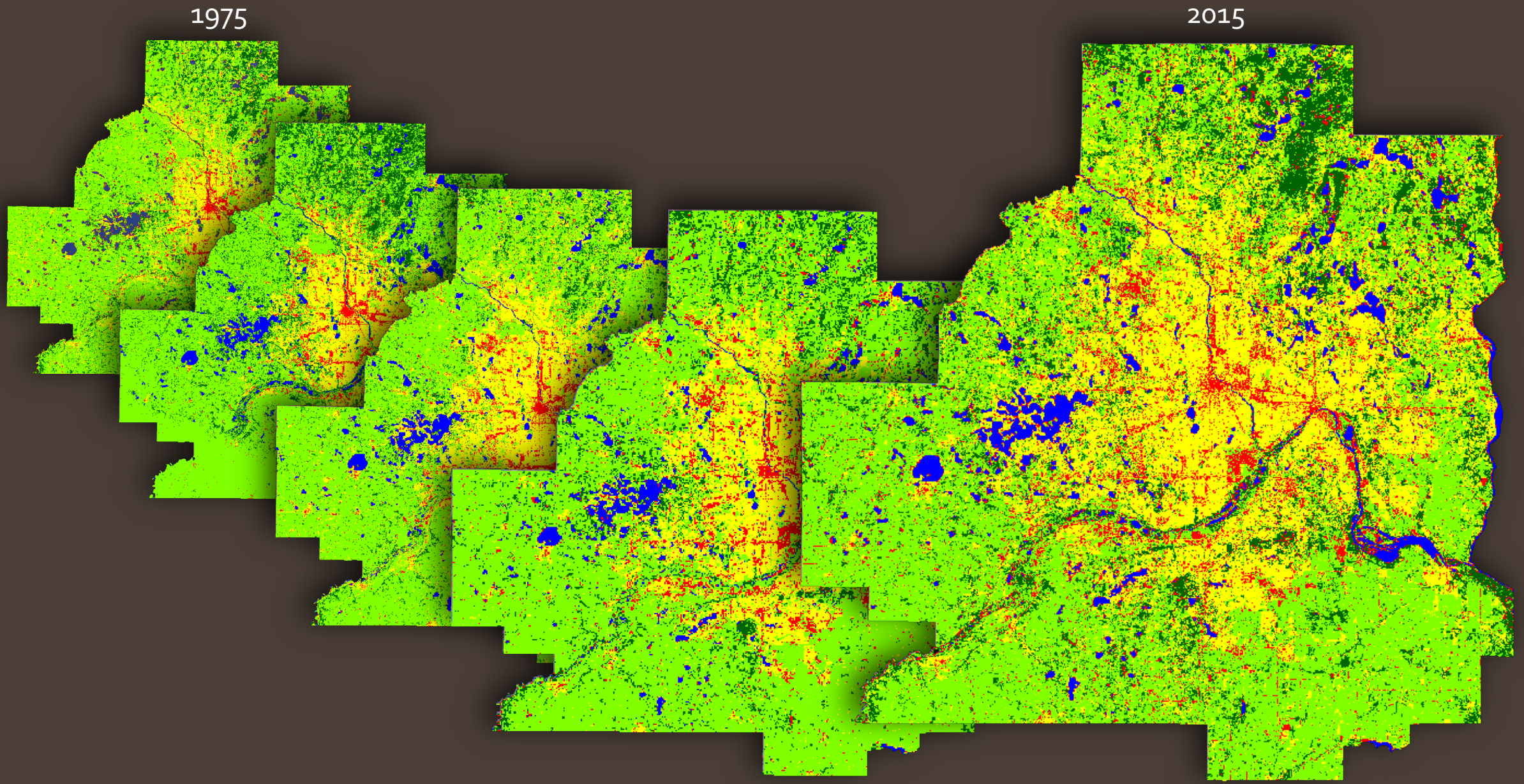


2015 Classification

Urban + Suburban Acreage =

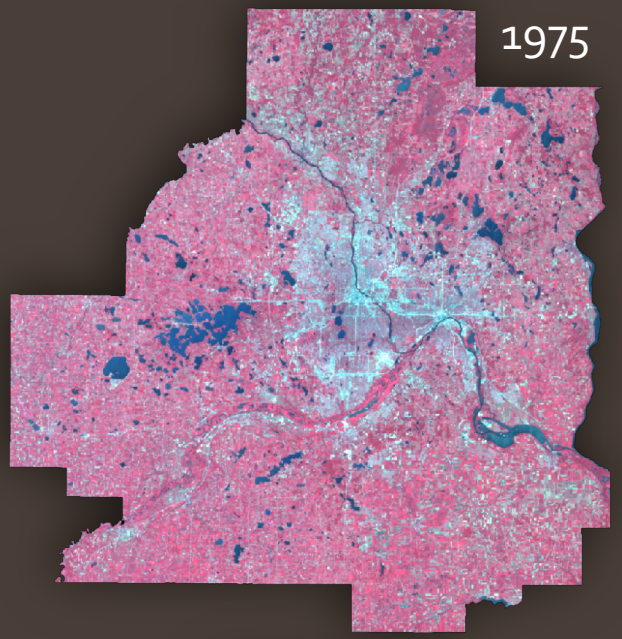
705,641

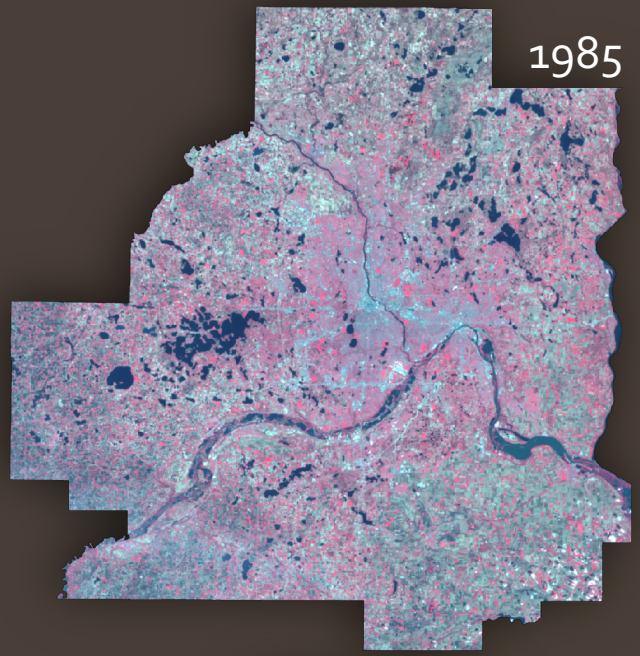


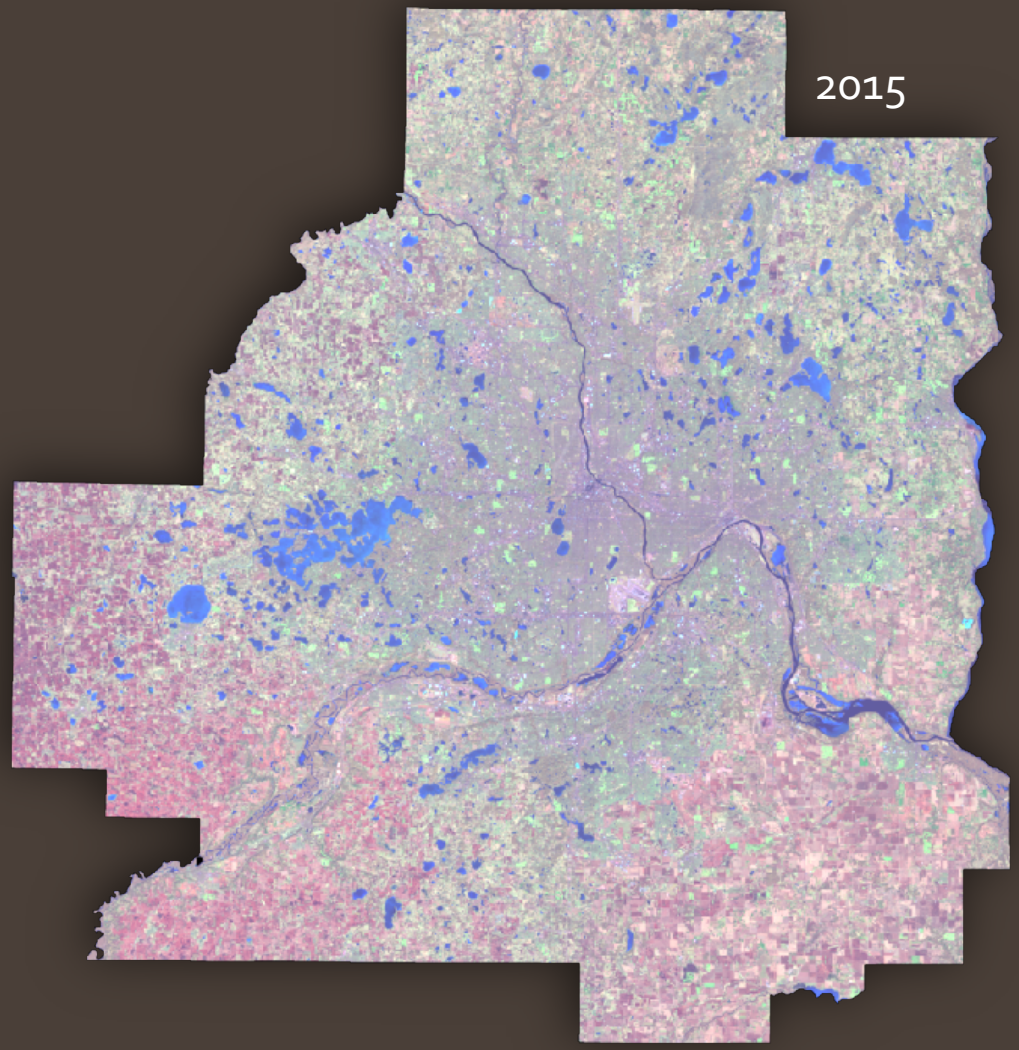

1975
2015

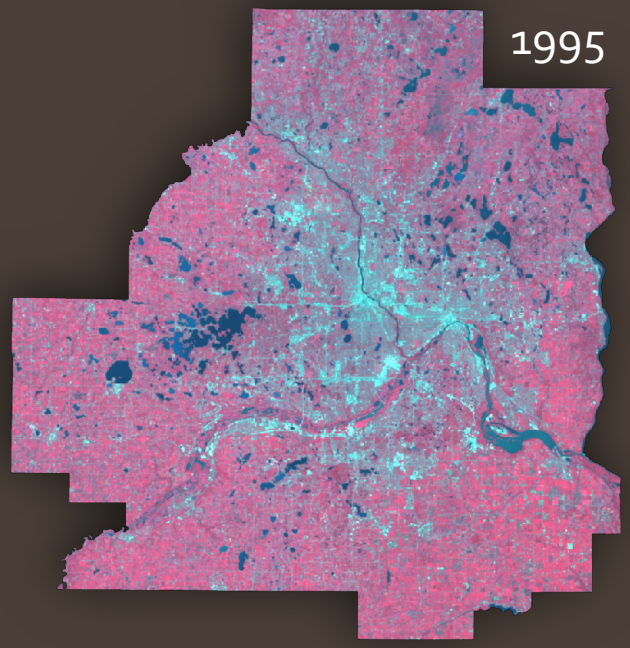
Issues with Classification

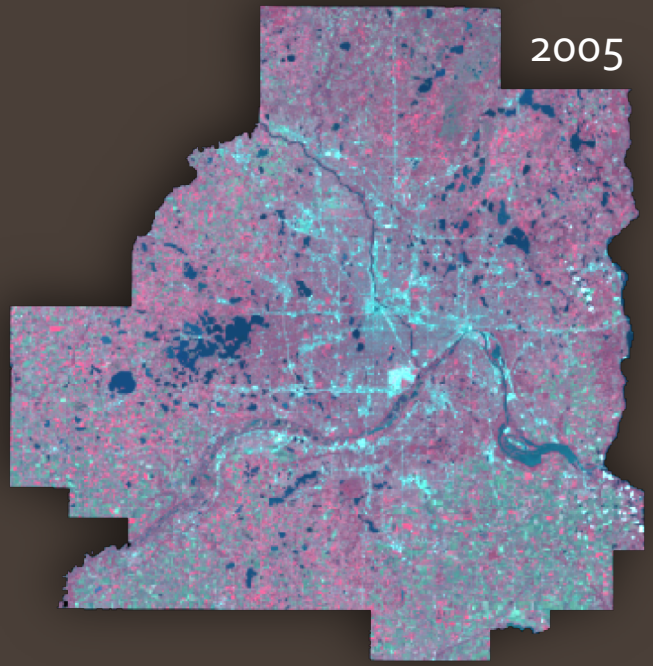
- Cloud interference
- Misclassification on small scale, causing figure changes
  - Boundary of urban area still grows
- Problems with images themselves (brightness, clarity)


1975


1985


2015


1995


2005

Accuracy Assessment

- Accuracy Assessment is a nice benchmark to see how well you classified your data
  - Raster -> Supervised -> Accuracy Assessment
- Used 50 random points

1975 Accuracy Assessment

Editor: 1975_accuracy.txt, Dir: i:/classes/g474_01_sp18/students/dardis_tyler_james/final project/data...

File Edit View Find Help

```
                ----- End of Error Matrix -----


ACCURACY TOTALS
---------------

          Class  Reference      Classified      Number  Producers       Users
           Name     Totals         Totals     Correct   Accuracy    Accuracy
     ---------- ----------     ----------     ------- ---------     -------
   Unclassified          0              0           0        ---         ---
          Water          1              1           1    100.00%     100.00%
          Urban          2              2           1     50.00%      50.00%
       Suburban         13             10           9     69.23%      90.00%
Cropland, Non-U         32             34          29     90.63%      85.29%
         Forest          2              3           2    100.00%      66.67%

         Totals         50             50          42

Overall Classification Accuracy =     84.00%

                ----- End of Accuracy Totals -----


KAPPA (K^) STATISTICS
---------------------

Overall Kappa Statistics = 0.6853

Conditional Kappa for each Category.
------------------------------------

           Class Name            Kappa
           ----------            -----
         Unclassified           0.0000
                Water           1.0000
                Urban           0.4792
             Suburban           0.8649
  Cropland, Non-Urban           0.5915
               Forest           0.6528

                ----- End of Kappa Statistics -----
```

1985 Accuracy Assessment

Editor: ECAAR006356, Dir: C:/Users/yq0131wl/AppData/Local/Temp/

File Edit View Find Help

----- End of Error Matrix -----

ACCURACY TOTALS

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Unclassified	0	0	0	---	---
Water	2	2	2	100.00%	100.00%
Urban	3	3	3	100.00%	100.00%
Suburban	3	2	2	66.67%	100.00%
Cropland, Non-U	32	30	29	90.63%	96.67%
Forest	10	13	10	100.00%	76.92%
Totals	50	50	46		

Overall Classification Accuracy = 92.00%

----- End of Accuracy Totals -----

KAPPA (K^) STATISTICS

Overall Kappa Statistics = 0.8562

Conditional Kappa for each Category.

Class Name	Kappa
Unclassified	0.0000
Water	1.0000
Urban	1.0000
Suburban	1.0000
Cropland, Non-Urban	0.9074
Forest	0.7115

----- End of Kappa Statistics -----

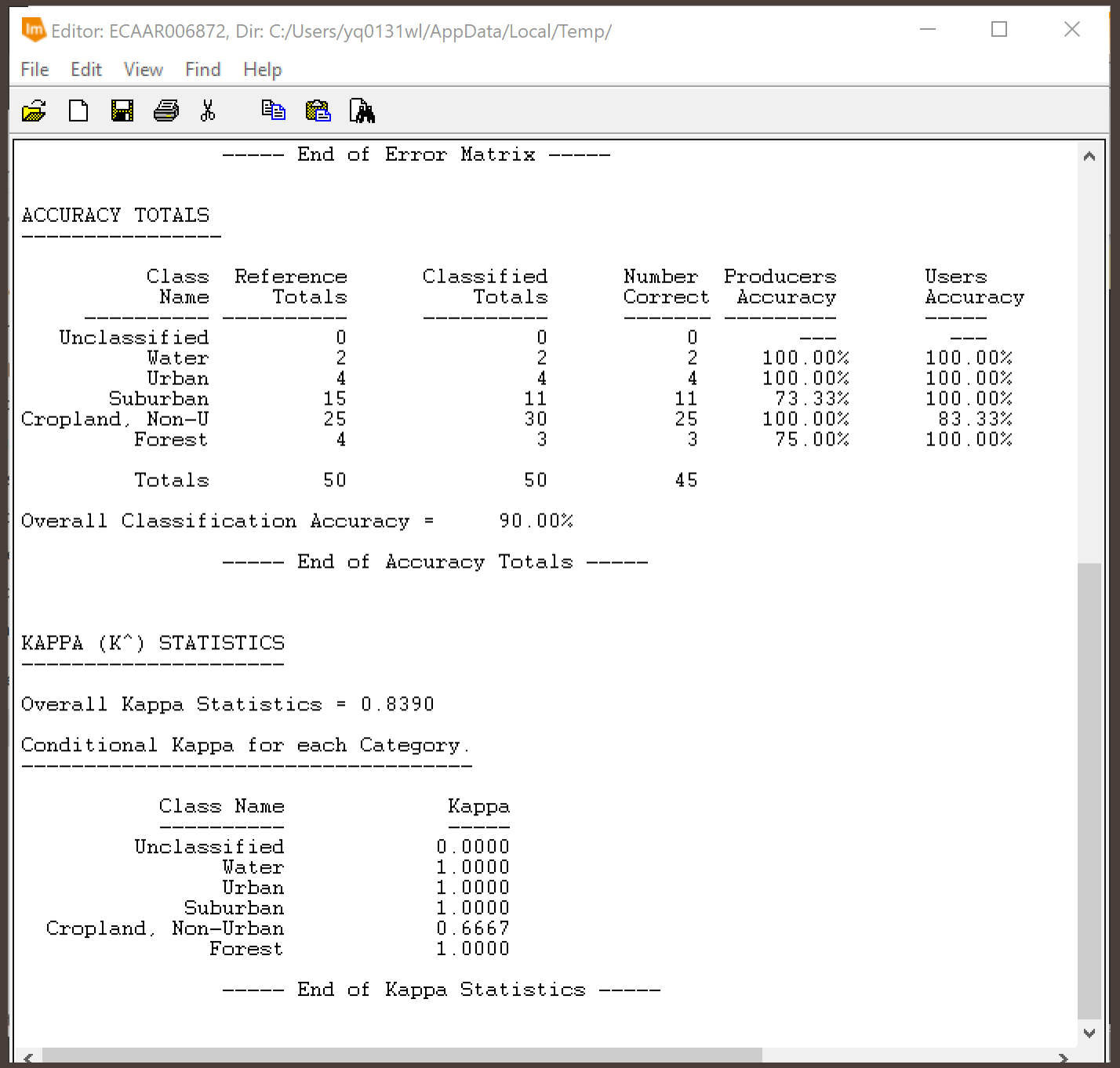
1995 Accuracy Assessment

Editor: ECAAR011608, Dir: C:/Users/yq0131wl/AppData/Local/Temp/

File Edit View Find Help

```
                ----- End of Error Matrix -----


ACCURACY TOTALS
---------------

          Class  Reference      Classified      Number  Producers       Users
           Name     Totals         Totals     Correct   Accuracy    Accuracy
     ---------- ----------     ----------     ------- ----------     -----
   Unclassified          0              0           0        ---        ---
          Water          2              2           2    100.00%    100.00%
          Urban          1              1           1    100.00%    100.00%
       Suburban         13             16          13    100.00%     81.25%
Cropland, Non-U         28             29          26     92.86%     89.66%
         Forest          6              2           2     33.33%    100.00%

         Totals         50             50          44

Overall Classification Accuracy =     88.00%

                ----- End of Accuracy Totals -----


KAPPA (K^) STATISTICS
---------------------

Overall Kappa Statistics = 0.7949

Conditional Kappa for each Category.
------------------------------------

           Class Name             Kappa
           ----------             -----
         Unclassified            0.0000
                Water            1.0000
                Urban            1.0000
             Suburban            0.7466
  Cropland, Non-Urban            0.7649
               Forest            1.0000

                ----- End of Kappa Statistics -----
```

2005 Accuracy Assessment


Editor: ECAAR006872, Dir: C:/Users/yq0131wl/AppData/Local/Temp/

File Edit View Find Help

----- End of Error Matrix -----

ACCURACY TOTALS

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Unclassified	0	0	0	---	---
Water	2	2	2	100.00%	100.00%
Urban	4	4	4	100.00%	100.00%
Suburban	15	11	11	73.33%	100.00%
Cropland, Non-U	25	30	25	100.00%	83.33%
Forest	4	3	3	75.00%	100.00%
Totals	50	50	45		

Overall Classification Accuracy = 90.00%

----- End of Accuracy Totals -----

KAPPA (K^) STATISTICS

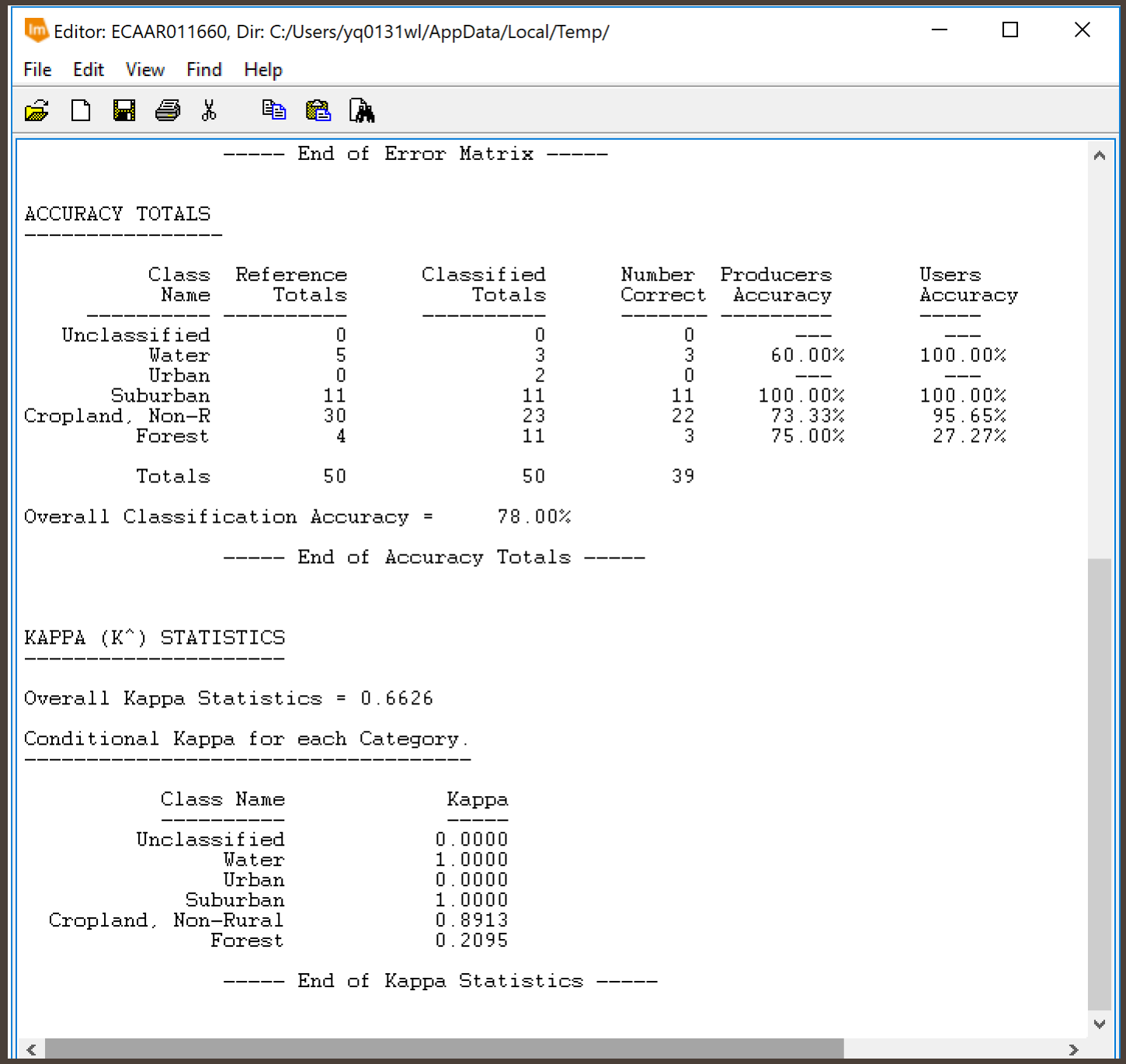
Overall Kappa Statistics = 0.8390

Conditional Kappa for each Category.

Class Name	Kappa
Unclassified	0.0000
Water	1.0000
Urban	1.0000
Suburban	1.0000
Cropland, Non-Urban	0.6667
Forest	1.0000

----- End of Kappa Statistics -----

2015 Accuracy Assessment



Issues with Accuracy Assessment

- Many of the random points were in the non-urban area
- Very few in urban, suburban areas
  - If chosen one wrong, can make accuracy 50% or less

Results

- Final Change Detection Map from 1975-2015
  - Answers the question of **where** change happened
- Trend of Urban Growth in comparison with Population Growth
  - Answers the question of **when** change happened
    - Is it speeding up, slowing down?

Change Detection

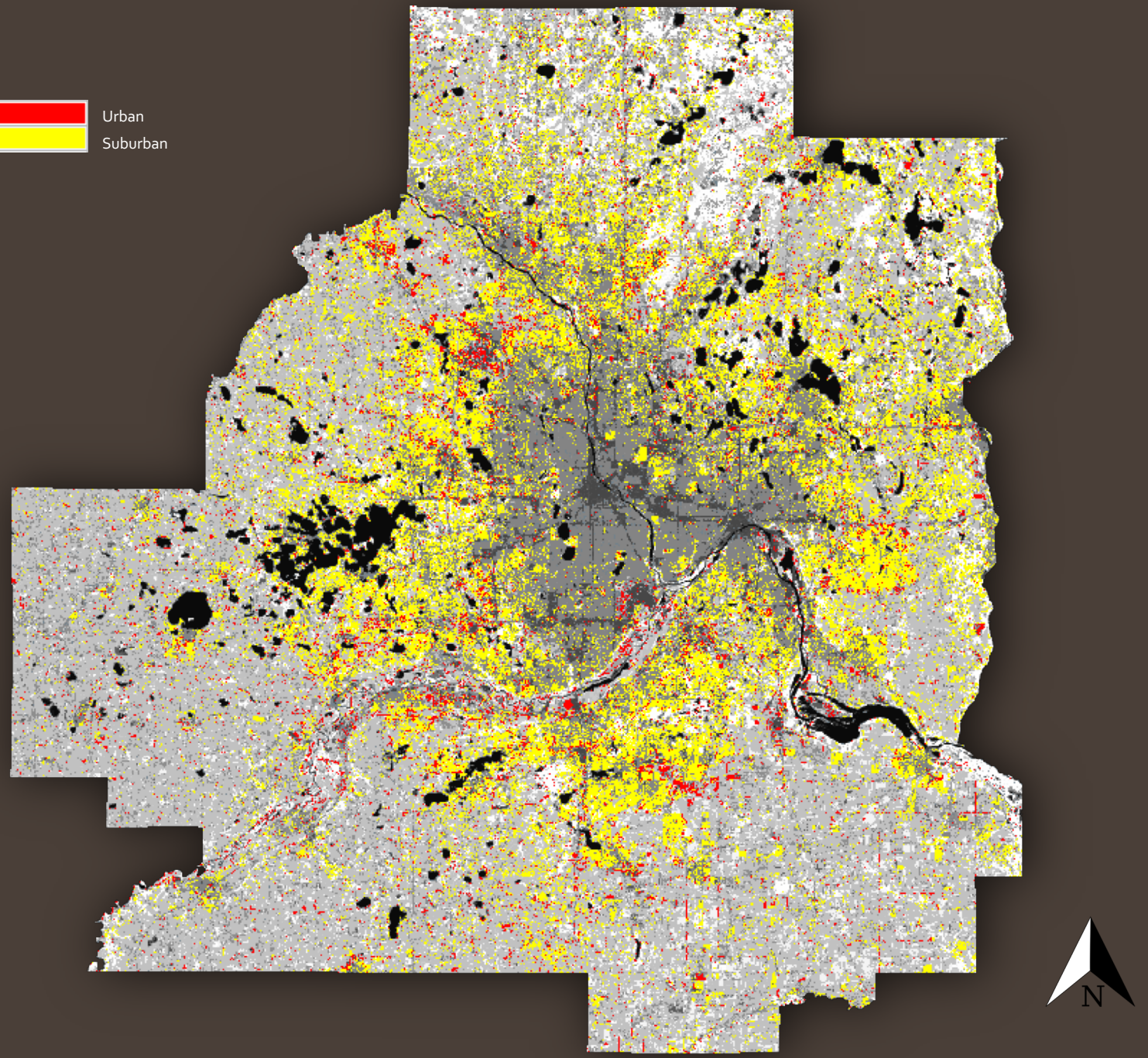
Urban
Suburban

From **1975-2015**

Total Additional Urban Acreage =

400,360

Concentrations on fringe, and dispersion as you go further out

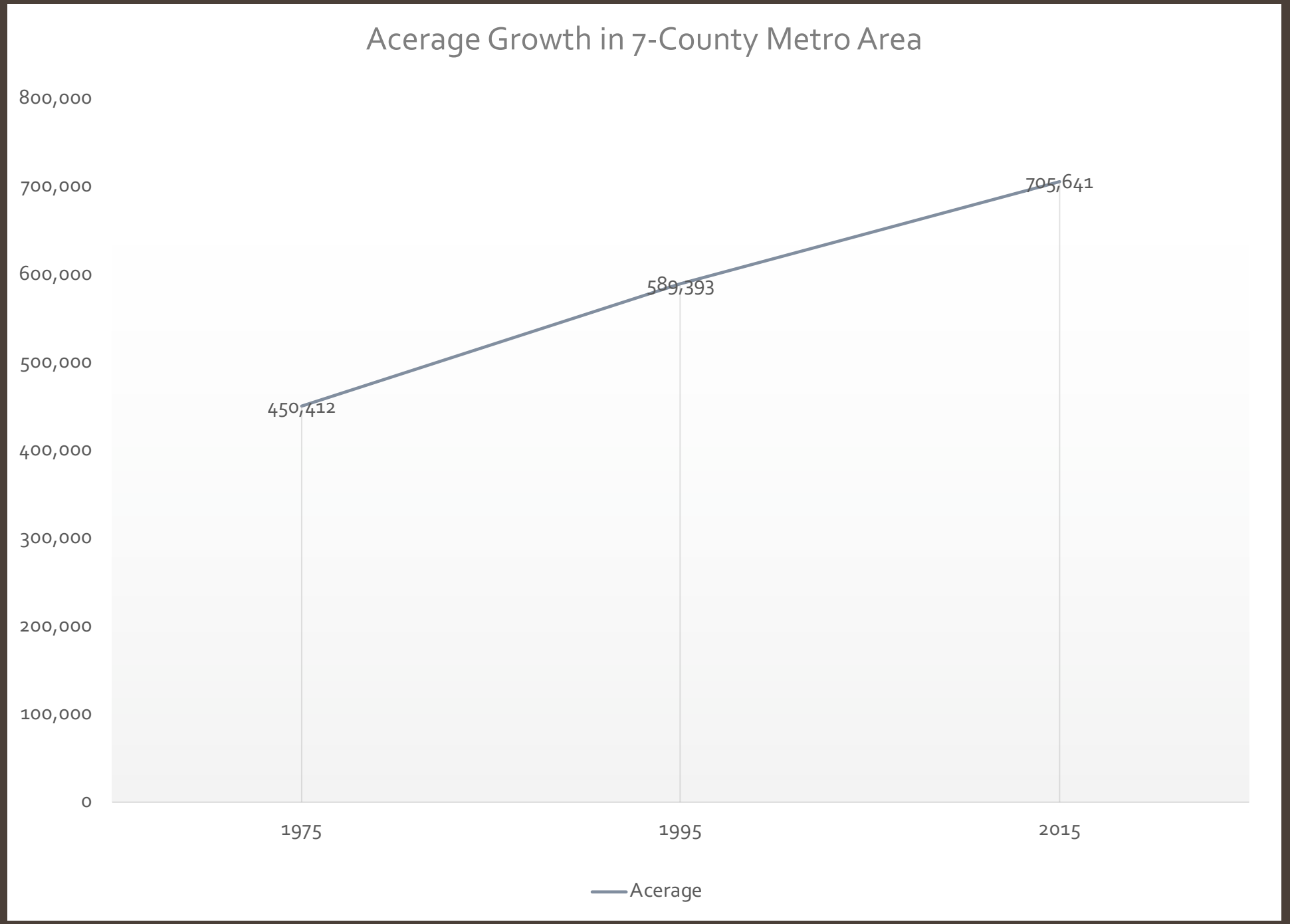


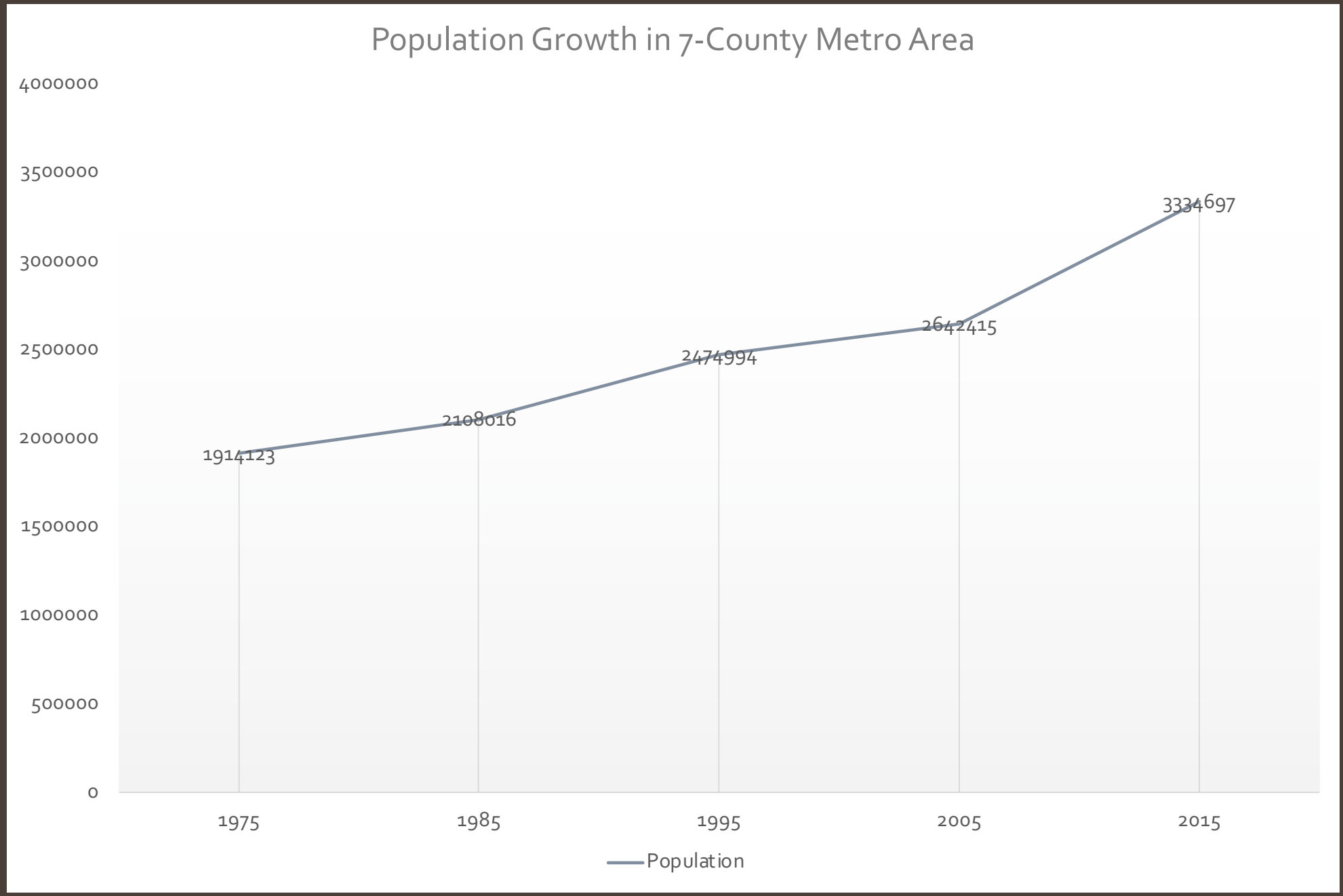
Change Detection Table

Row	Histogram	1975_sup_class value	2015_sup_class value	Color	Opacity	Area
0	3243836	0	0		1	721413
1	277301	1	1		1	61670.4
2	27815	1	2		1	6185.92
3	498	1	3		1	110.753
4	1267	1	4		1	281.774
5	1110	1	5		1	246.858
6	41558	2	1		1	9242.29
7	174695	2	2		1	38851.3
8	97945	2	3		1	21782.5
9	47096	2	4		1	10473.9
10	5237	2	5		1	1164.68
11	14256	3	1		1	3170.46
12	201137	3	2		1	44731.9
13	869905	3	3		1	193463
14	468401	3	4		1	104170
15	100379	3	5		1	22323.8
16	10190	4	1		1	2266.21
17	273167	4	2		1	60751
18	1263607	4	3		1	281020
19	2909925	4	4		1	647153
20	574979	4	5		1	127872
21	2765	5	1		1	614.922
22	50744	5	2		1	11285.2
23	212706	5	3		1	47304.8
24	362031	5	4		1	80513.9
25	576698	5	5		1	128255

Observations

- New Suburbs are much more spread out, not cramped
  - Could have also caused issues with classifications


Acerage Growth in 7-County Metro Area
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
450,412
589,393
705,641
1975
1995
2015
Acerage


Population Growth in 7-County Metro Area
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
1914123
2108016
2474994
2642415
3334697
1975
1985
1995
2005
2015
Population

Results

- According to three points of data:
  - Urban Growth is steady to slowing
  - Could indicate slowing of urban sprawl
    - Increase in Urban Revitalization
  - Restrictions of expansion, Urban Growth Boundaries (UGB)
    - Needs more data
  - Supported by continued increase in population in recent years

- Project opens the door for continued and more detailed research into trends of the metro's growth in relation to area, and population

Improvements

- More accurate and defined classification
- Use of higher resolution imagery for detailed, accurate classifications
  - Use of Feature Analyst
- Research into UGBs in Minnesota Metro
- Greater understanding of both the area, and image interpretation