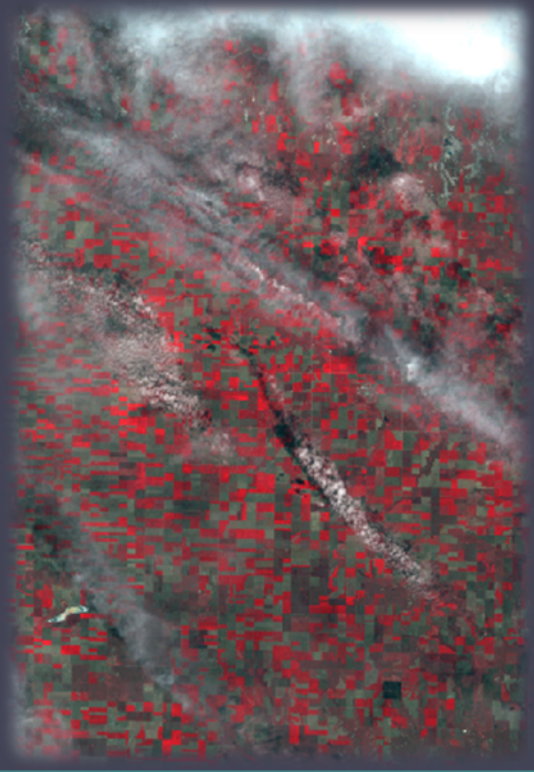
Mapping and Recovering Cloud-contaminated Area in Optical Satellite Imagery



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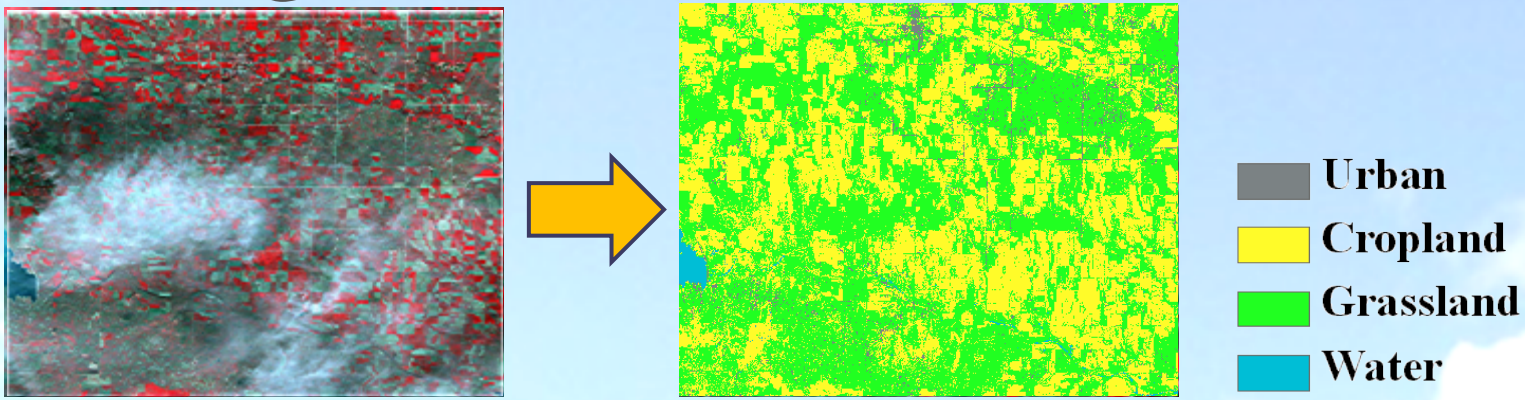
Research Questions



- Can we delineate thick cloud and remove haze without additional cloud-free reference areas or imagery?
  - Region growing → Detect unrecoverable thick cloud
  - Fourier analysis → Recover ground information from haze
- Can we delineate thick cloud and remove haze only with Green, Red, and Near Infrared bands?
  - Use Landsat-5 TM and Formosat-2 Green, Red, and NIR bands
- Can we assess cloud processing results with quantitative methods?
  - Use expert method and image classification
- Can we apply haze-off imagery to image classification?
  - Image classification → evaluate the recovery degree

Thick Cloud Delineation—Methods

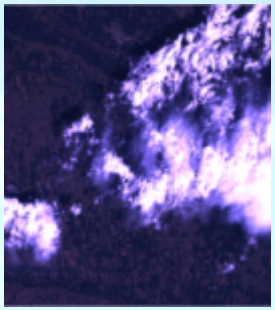


Image with thick cloud

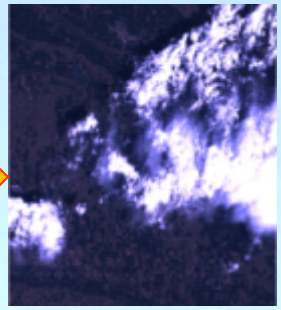


Image after first enhancement

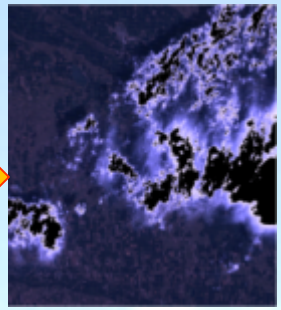


Image after first thresholding (230)

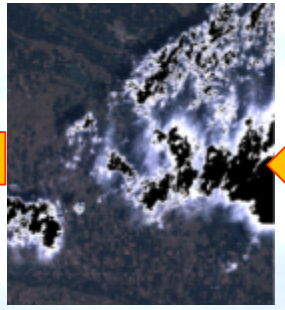


Image after second enhancement

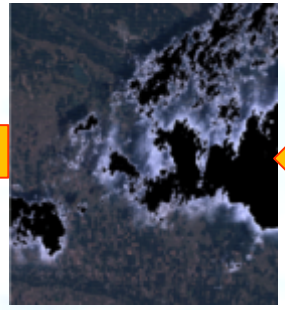
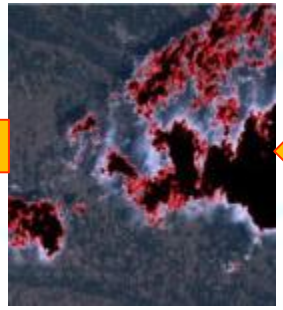


Image after second thresholding (230)

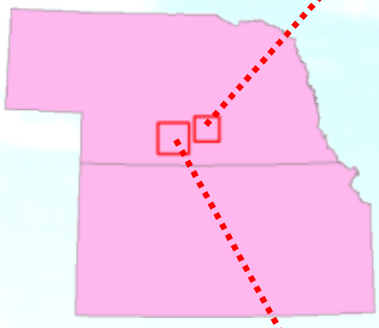


Seeds produced with morphology

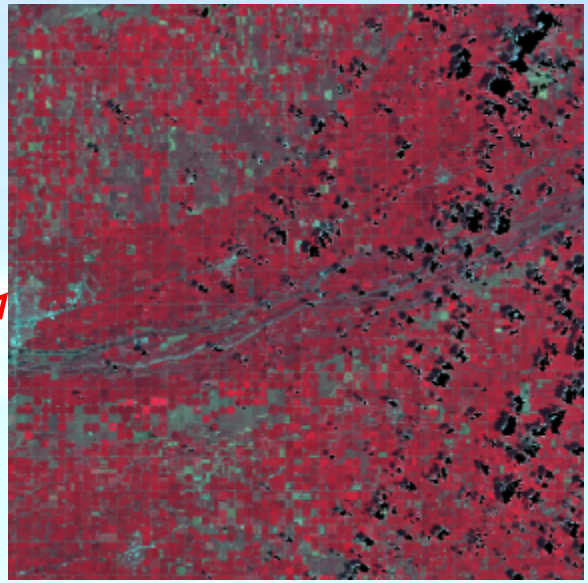
Detection result after region growing

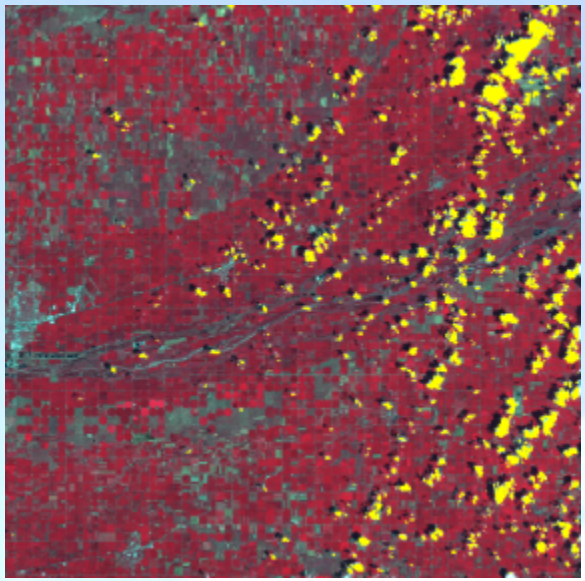
(threshold:30)

Thick Cloud Delineation—Results

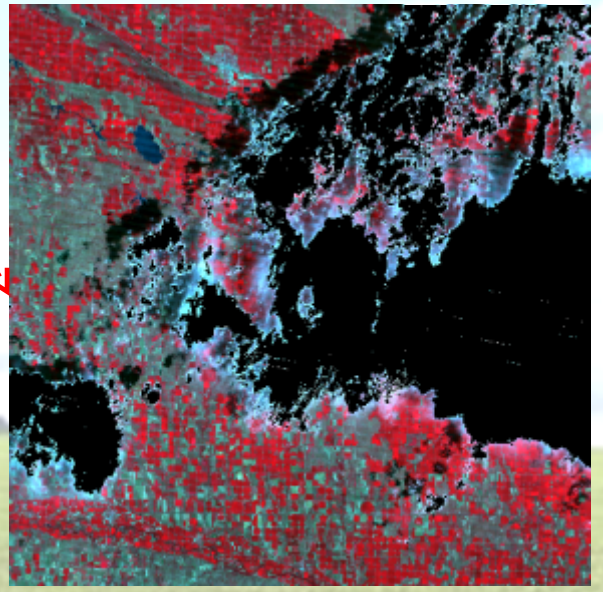


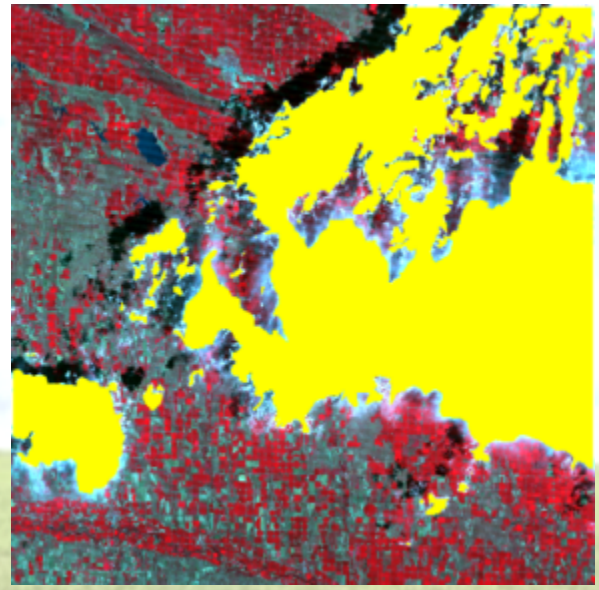
Landsat-5 TM
Nebraska





Overall Acc.:
99.58%
Kappa:
0.945



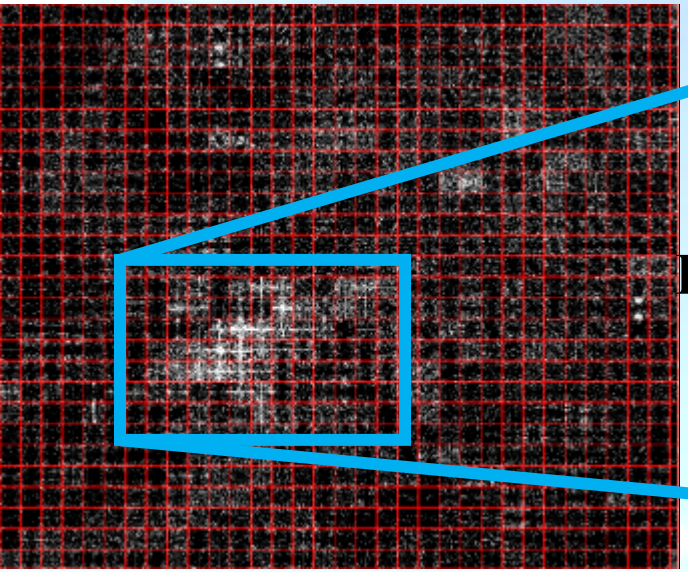


Overall Acc.:
94.75%
Kappa:
0.883

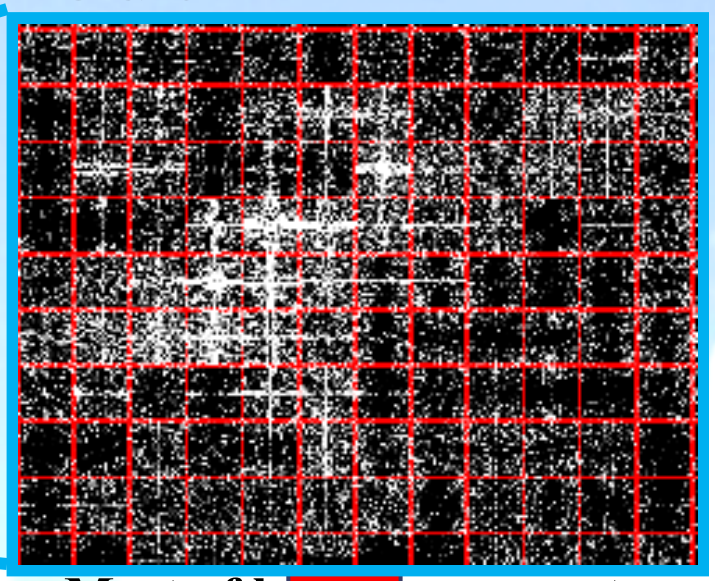
Cloud Processing Results

Expert Method Results

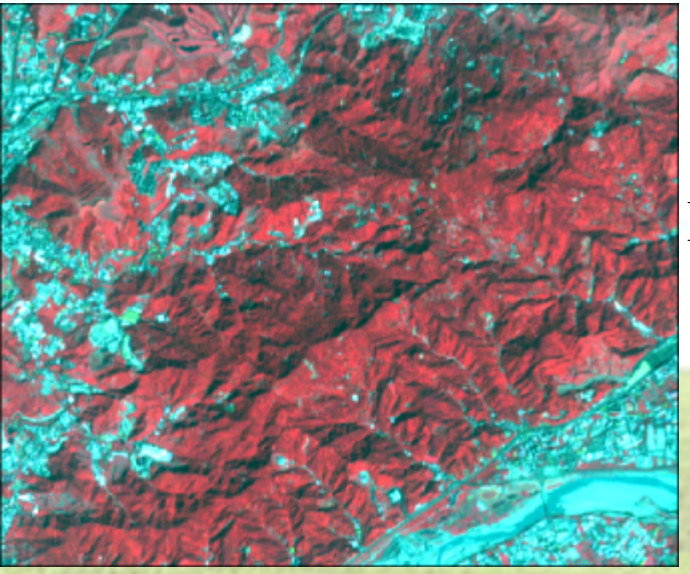
Haze Removal—Methods



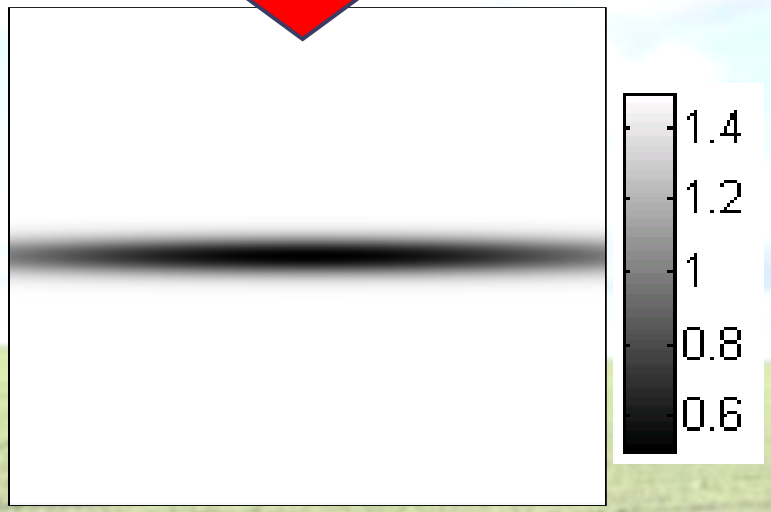
11/05/2004
FORMOSAT-2
(hazy)
Difference of
Fourier
magnitude



Most of haze components disperse along X axis

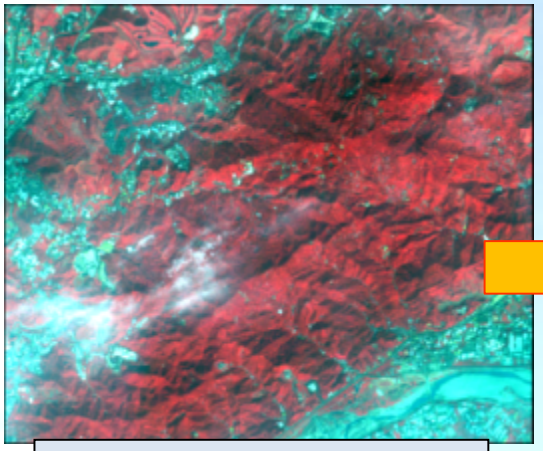


11/04/2004
FORMOSAT-2
(clear, after
relative
radiometric
correction)

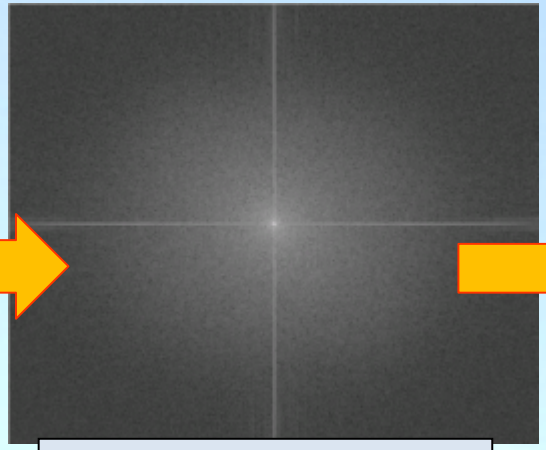


Design a filter to filter haze

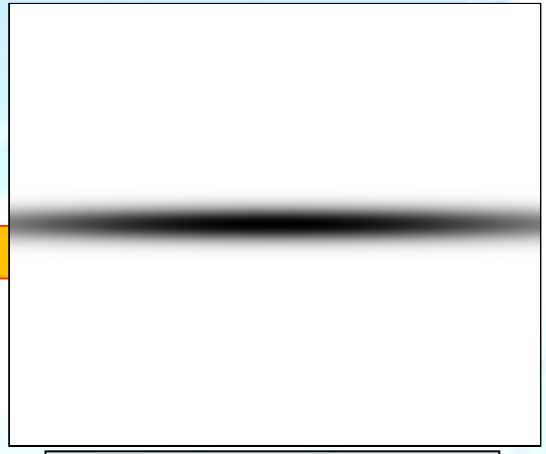
Haze Removal—Methods



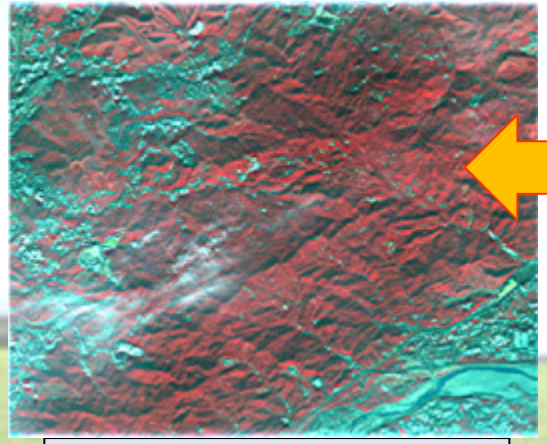
Original hazy image



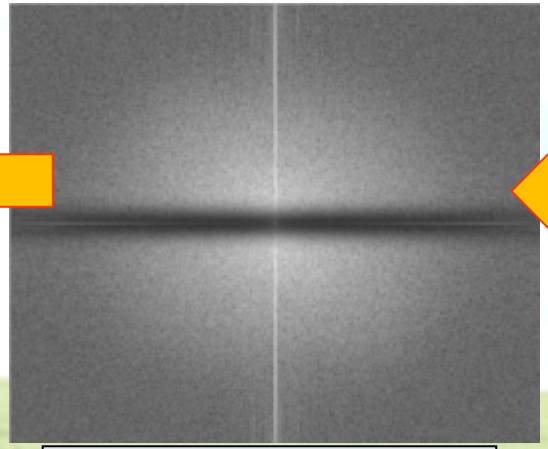
Fourier spectrum of the hazy image



Filter

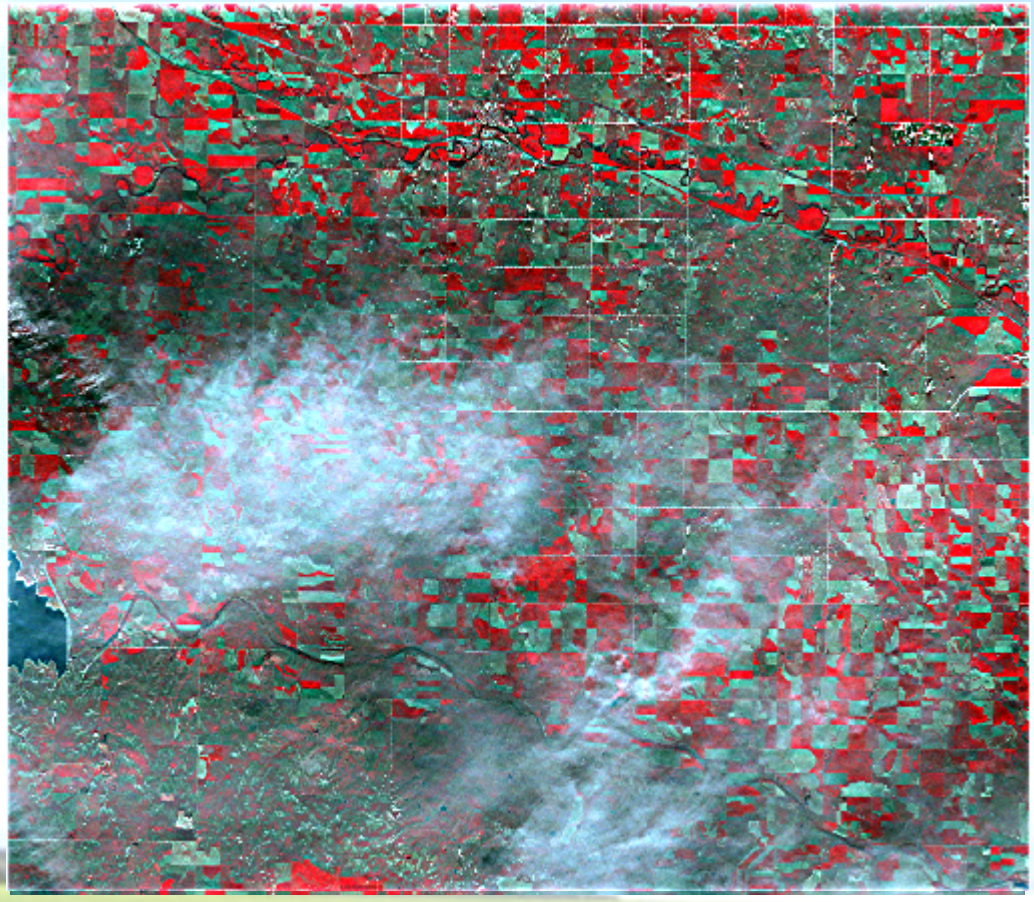


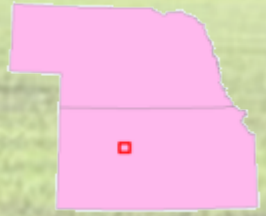
Haze-off image



Fourier spectrum after filtering

Haze Removal—Results





Landsat-5 TM
Kansas

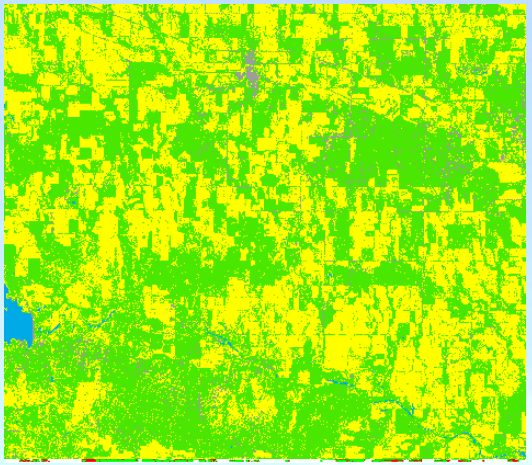


Image classification
result of the hazy image

Urban
Cropland
Grassland
Water

Overall Acc.:
80.77%
Kappa:
0.348

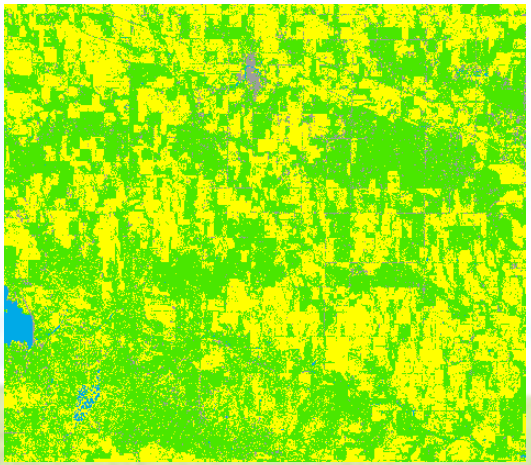


Image classification result of
the hazy-off image

Overall Acc.:
78.41%
Kappa:
0.314

Summary

- **Future applications**
  - **Preprocessing of satellite imagery in land use/cover mapping**
  - **Decrease manpower to interpret and remove thick cloud areas**
  - **Increase usability of satellite imagery served as base maps**
- **Cloud processing only using Green, Red, NIR bands without cloud-free reference areas or imagery**
  - **Sufficient for thick cloud delineation**
  - **Achieve some visual improvement in haze removal**
- **Assess cloud processing results with quantitative methods**
  - **Expert method could provide quantitative assessment. But who? How many?**
  - **Image classification could be good assessment before applying haze-off imagery to land use mapping**
- **Apply haze-off imagery to image classification**
  - **Risks may exist when using processed imagery in this study**

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