Practical applications of accuracy assessment in large area land cover and land cover change monitoring with satellite data

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What is accuracy assessment?

- When a map (LC or LCC) is derived from remotely sensed data, that map is considered to be only a hypothesis!
- As with other hypothesis-based problems, the hypothesis has to be tested with data
- Testing is done by extracting samples from the map, compare these samples to a known reference
- Then accuracy can be reported using a variety of metrics and a degree of confidence can be attached to the results

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Common questions in accuracy assessment

- What is my sample and how do I extract it?

A sample is a subset of a population – in general, the population (the pixels in a map) is very large, making a census of all the values impractical or impossible

- The sample represents a subset of manageable size

- Samples are collected and statistics are calculated from the samples so that one can make inferences or extrapolations from the sample to the population (the map) with known confidence intervals

- This process of collecting information from a sample is referred to as sampling

How do you collect reference data?

- Back-classification of training data
  – Use your own training data to see how well you did!

- Cross-validation
  –Don’t make a map, use training data splits

- Independent (spatially) non-random samples
  –systematic, clustered, multi-stage etc.

- Independent (spatially) random samples
  – either stratified or not stratified (based on class value)

What about the sample size?

Sample size depends on a number of factors including:

- Expected accuracy
- Desired accuracy
- Desired level of confidence interval
- ultimately the resources available (accuracy assessment is expensive!)

A common approach is to decide on the total sample number first and allocate based on the problem

How to allocate?

- Proportional allocation: allocate samples based on the size (area) of the map category

- Proportional allocation works well in situations where the categories have sizable representation on the map

- It does not work well in change detection studies as the most important class (the change category) often the smallest (area-wise) category on the map

Common questions in accuracy assessment

- What is my sample and how do I extract it?
- What is my metric to measure accuracy?

Tools and metrics to use

- For categorical outcomes (i.e. classification or change detection) confusion matrix is the standard tool
- Report all accuracies (overall, class-specific, omission/commission, kappa etc.)
- For continuous outcomes (i.e. forest fraction) various statistical tools (correlation, goodness of fit etc.) can be used
- The most important thing to remember is to be transparent and show all of the work and the data!

Common questions in accuracy assessment

- What is my sample and how do I extract it?
- What is my metric to measure accuracy?
- Do I need to worry about spatial autocorrelation?

Spatial auto-correlation

- Spatial auto-correlation is correlation that occurs when near things are more related than far things
- Can negatively impact statistical analyses (accuracy assessment)
- The most important effect is that it inflates accuracy results!!
- Estimate correlation length (variogram) and choose samples beyond this correlation length
- In general, only applied in situations with a large sample - if have small sample - can’t be picky!

Common questions in accuracy assessment

- What is my sample and how do I extract it?
- What is my metric to measure accuracy?
- Do I need to worry about spatial autocorrelation?
- What is a good accuracy?

What is a good accuracy?

- Well that depends!
- Obviously we all want the products with the highest/best accuracy
- Inverse relationship between the categorical detail and accuracy (more categories - expect reduced accuracy)
- Class specific accuracies matter as much as the overall accuracy of the product
- Change detection problems are inherently more difficult so perhaps lower expectation

Things not to do

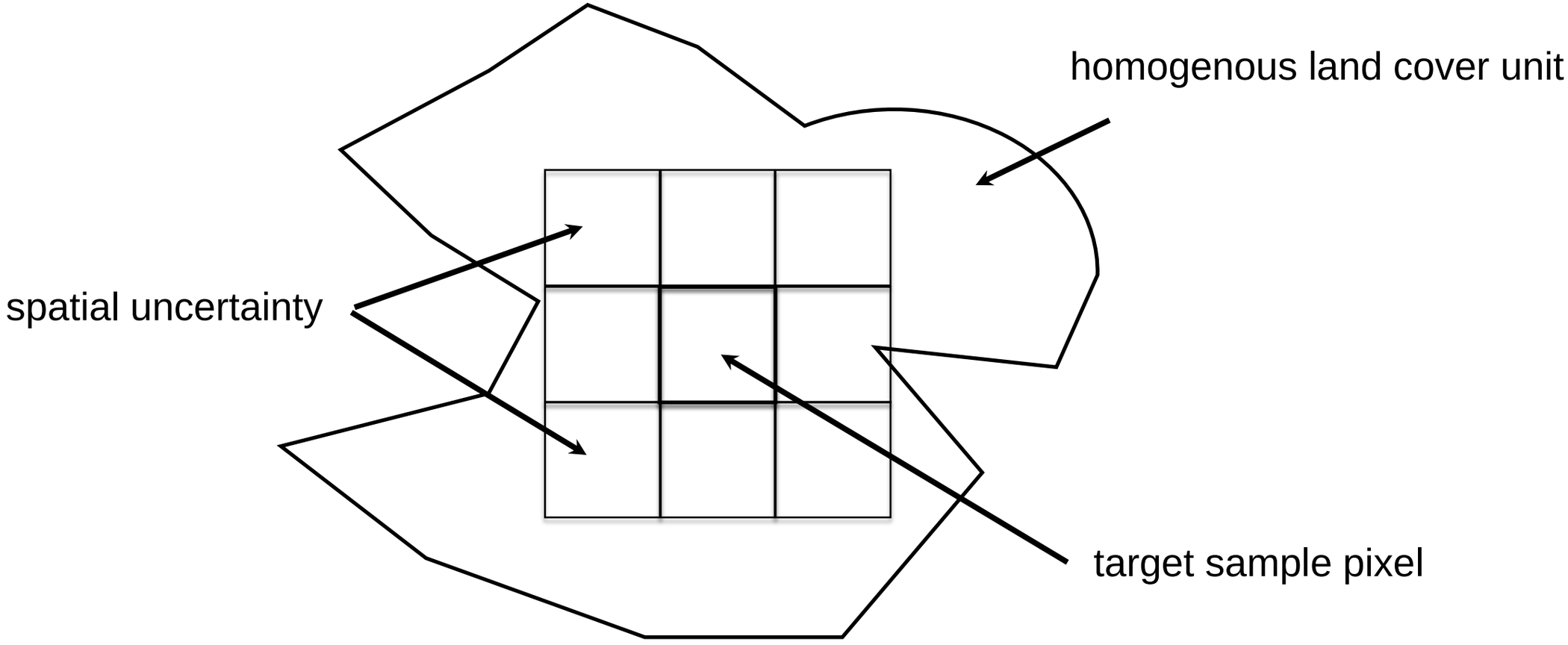
- Not assess accuracy
- Use training data in accuracy assessment (maybe used as an initial check)
- Use products without known accuracy
- Deliver products without known accuracy
- Use unreliable reference data
- Use single pixels (especially at higher spatial resolution) to perform accuracy
- Use small sample sizes - especially for important (but small) categories

Things we need to do

- Always perform accuracy assessment
- Report/demand validation results
- Report all accuracies and show/share sample data (transparency is important)
- Use accuracy assessment results to report corrected area estimates
- Use area-corrected accuracy assessment tools
- Allocate more resources to accuracy assessment

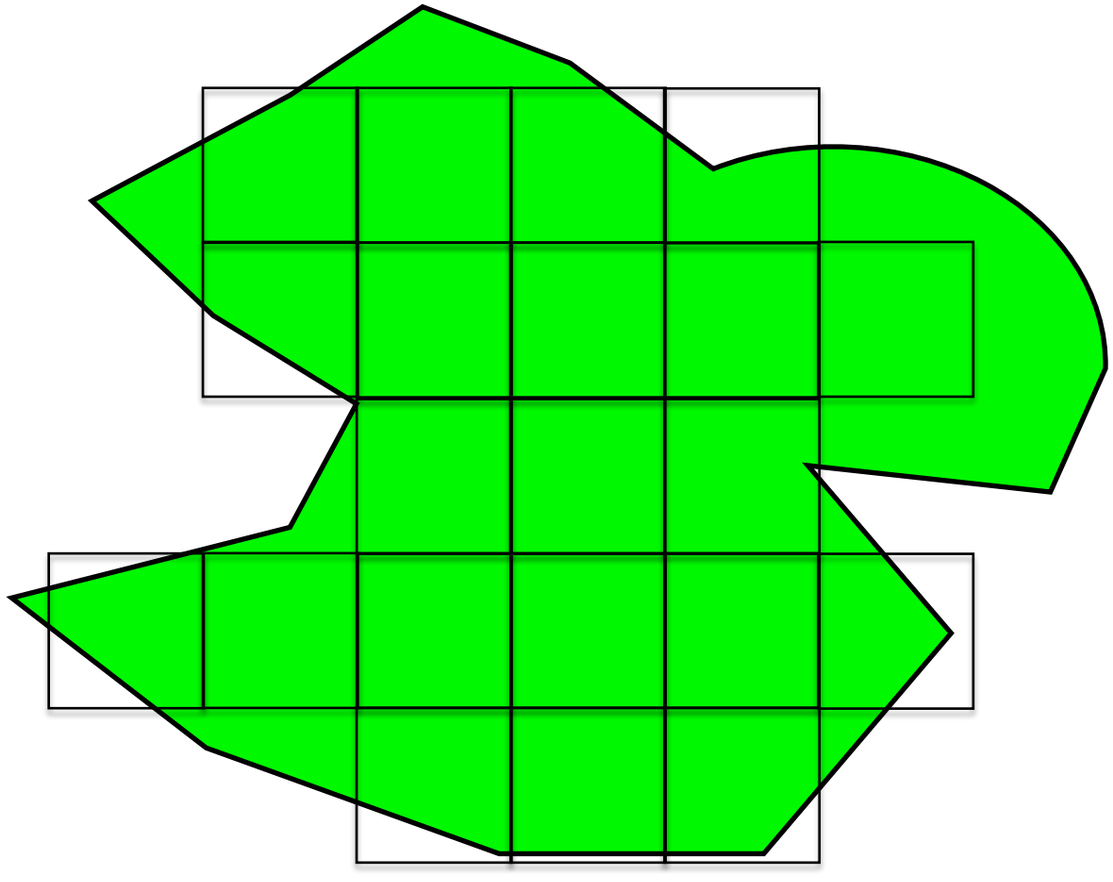
Loose ends in accuracy assessment (1)

- Single pixel accuracy assessment is problematic - especially in higher spatial resolution products
- Due to unknown location of the pixel (image registration always has problems)



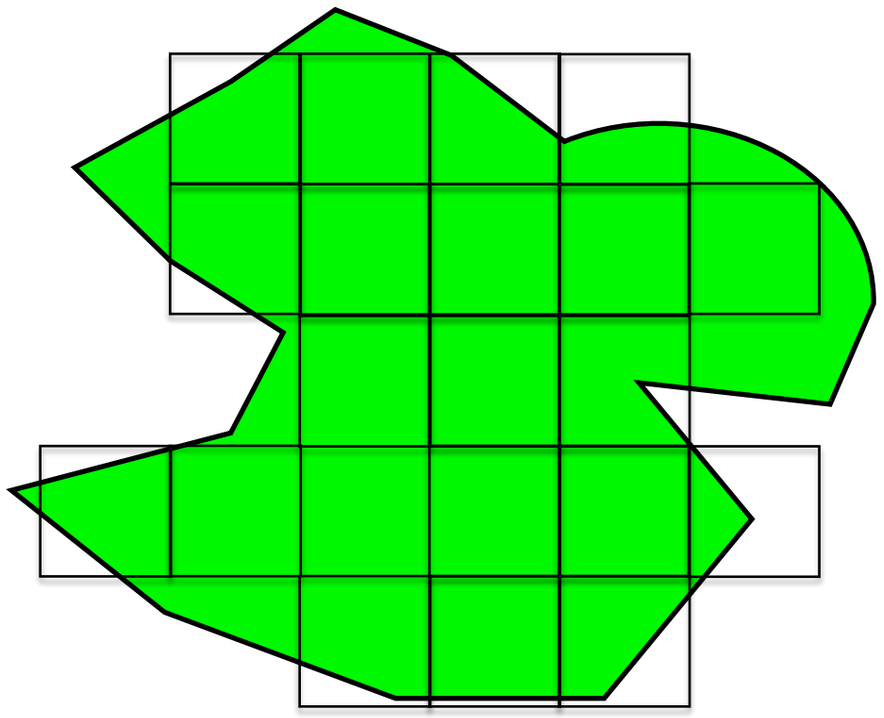
Loose ends in accuracy assessment (2)

- In site (region or polygon) based accuracy - we must sample the polygon and not the pixels in polygon
- Must find a way to interpret the polygon in the reference data (majority rule?)



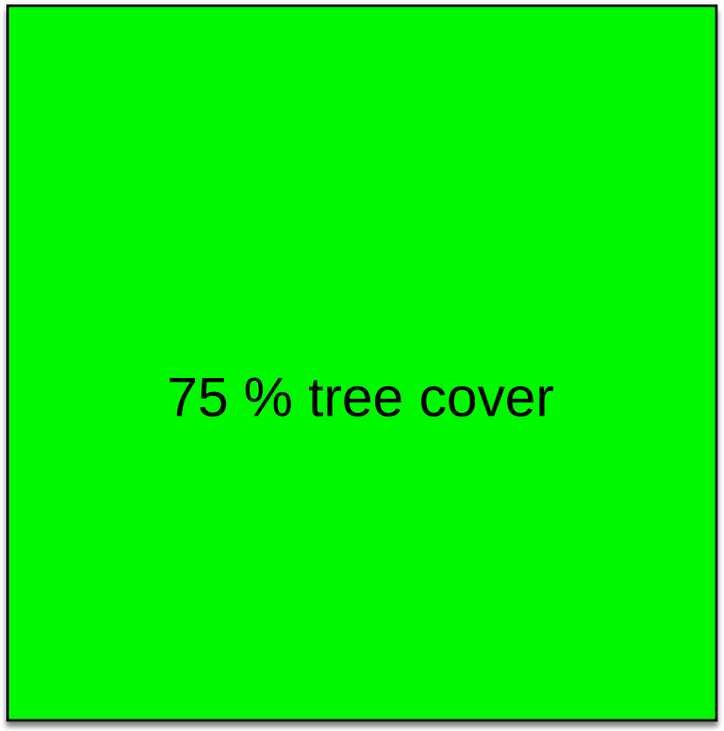
Loose ends in accuracy assessment (3)

- Must separate pixels from regions in cross-validation
- If you are using regions (polygons) as the map unit, you cannot use individual pixels from a region to do the cross-validation based accuracy assessment - regions and pixels must be kept together as either training or testing groups



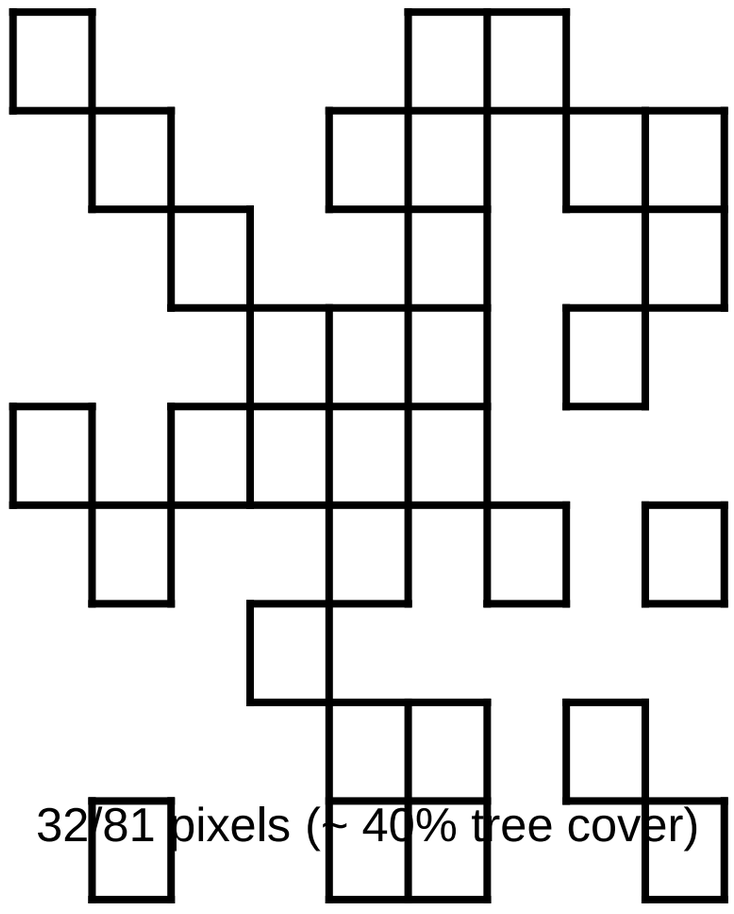
Loose ends in accuracy assessment (4)

- For continuous outcomes (i.e. tree fraction) we need to generate continuous reference sets

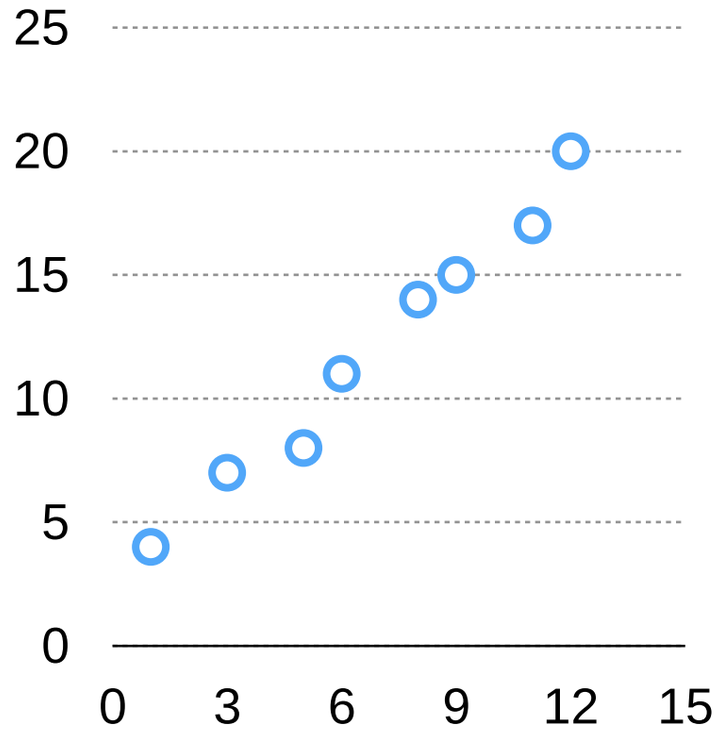


30 meter pixel

reference high resolution map



32/81 pixels (~ 40% tree cover)



Summary

- Accuracy assessment is important but expensive
- Must incorporate accuracy assessment into original planning - can’t be treated as an afterthought
- Need to report all the work and (if possible) make sample data available (transparency is key)
- Need to move away from single pixel assessments (especially for high resolution products)
- There are tools to correct area estimates based on accuracy assessment as well as tools to perform area adjusted accuracies
- As a community we need to make accuracy assessment a priority

Thank you

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