

REMOTE SENSING : *Field work and GPS*

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Web for the Week:

<http://electronics.howstuffworks.com/gps.htm>

<http://www.cstars.ucdavis.edu/classes/ers186-w03/lecture17/lecture17.ppt>

Purposes of Field Data.

- To **verify, evaluate** or **assess** the results of remote sensing investigations (accuracy assessment).
- Provide data to geographically correct imagery.
- Provide information used **to model the spectral behaviour of landscape features** (plants, soils, or waterbodies).

Field data includes least three kinds of information.

- Attributes or **measurements that describe ground conditions** at a specific place.
- Observations must be linked to **locational information** so the attributes can be correctly matched to corresponding points in image data.
- Observations must also be described with respect to **time and date**.

Nominal Data

- Nominal labels consist of **qualitative designations** applied to regions delineated on imagery that convey basic differences from adjacent regions.
- Nominal labels are derived from different sources:
Established classification systems. (Say Fossitts Guide to Habitats in Ireland :

Origins in local terminology or in circumstances that are specific to a particular study.
- In the field nominal data are usually easy to collect at points or for small areas; difficulties arise as one attempts to apply labelling system to larger areas.
- For these reasons, it is usually convenient to annotate maps or aerial photographs in the field as a means of relating isolated point observations to areal units. Or if your good enough you can manually interpret the airphotos as if you we're in the field.

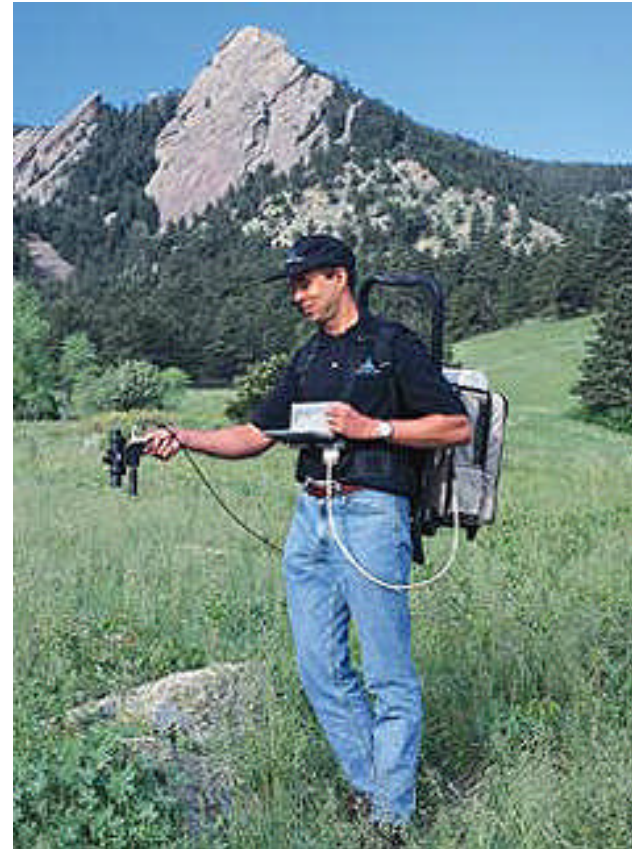
Biophysical Data

- Biophysical data consist of measurements of physical characteristics collected in the field.
- e.g, the type, size, form and spacing of plants that form the vegetative cover, or, the texture, drainage status and mineralogy of the soil.
- Biophysical data typically apply to points, so often they must be linked to areas by averaging of values from several observations within an area.
- Biophysical data must often be associated with nominal labels, so they do not replace nominal data but rather document the meaning of nominal labels. For example, biophysical data often document the biomass or structure of vegetation within a nominal class rather than completely replacing a nominal label.

FIELD RADIOMETRY

- Radiometric data permit the analyst to relate brightnesses recorded by the aerial sensor to corresponding brightnesses near the ground surface.
- A field spectrometer consists of a measuring unit with a hand held probe connected to the measuring unit by a fibre optic cable.

FIELD RADIOMETRY



Geographic Sampling

- **Observation** signifies the *selection of a specific cell* or pixel,
- **Sample** is used here to designate *a set of observations* that will be used in an error matrix.
- Three separate decisions must be made when sampling maps or spatial patterns.
 - (1) **Number** of observations to be used.
 - (2) **Sampling pattern** to position observations within an image.
 - (3) **Spacing** of observations.

Numbers of Observations

- Number of observations determines
 - the confidence interval of an estimate of the accuracy of a classification. A large sample size decreases the width of the confidence interval of our estimate of a statistic.
- For most purposes it is necessary to have some minimum number of observations assigned to each class.

Sampling Pattern.

The Simple Random Sampling Pattern

- The choice of any specific location as the site for an observation is **independent** of the selection of any other location as an observation.
- All portions of a region are **equally subject to selection for the sample**, thereby yielding data that accurately represent the area examined and satisfying one of the fundamental **requirements of inferential statistics**.

The Stratified Random Pattern

- **Assigns observations to sub-regions** of the image to ensure that the sampling effort is distributed in a rational manner. A stratified sampling effort might plan to assign specific number of observations to each category on a map to be evaluated. This procedure would ensure that every category would be sampled.

-

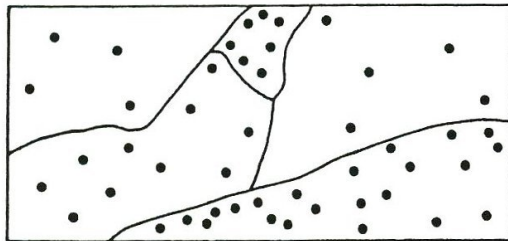
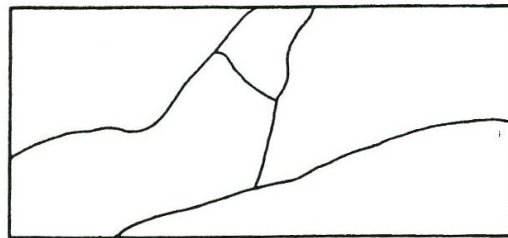
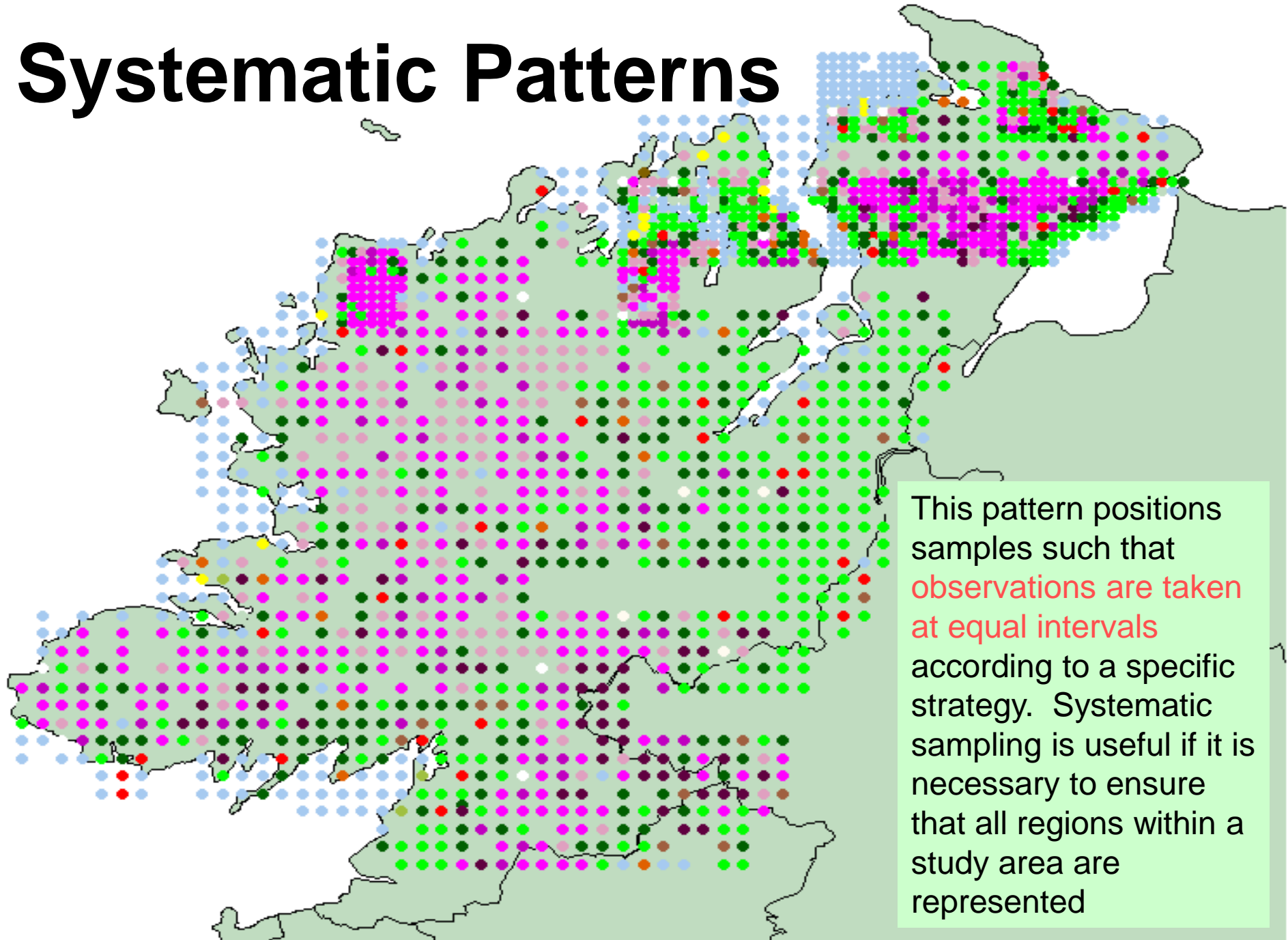


FIGURE 5 Stratified random sampling pattern. Here a region has been subdivided into subregions (*strata*) shown at the top. Samples are then allocated to each stratum in proportion to its expected significance to the study, then positioned randomly within each subarea.

Systematic Patterns



This pattern positions samples such that observations are taken at equal intervals according to a specific strategy. Systematic sampling is useful if it is necessary to ensure that all regions within a study area are represented

Systematic Stratified Unaligned Patterns

- This pattern combines features of both systematic and stratified samples while simultaneously preserving an element of randomness.
- The entire study area is divided into uniform cells.
- The grid cells introduce a systematic component to the sample and form the basis for the stratification; one observation is placed in each cell.
- An element of randomness is contributed by the method of placing observations within each cell.

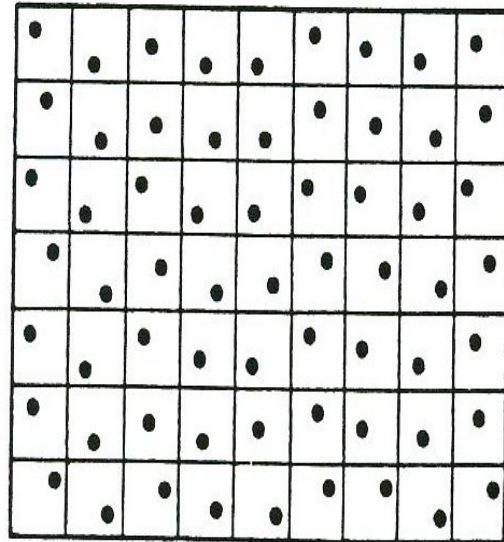
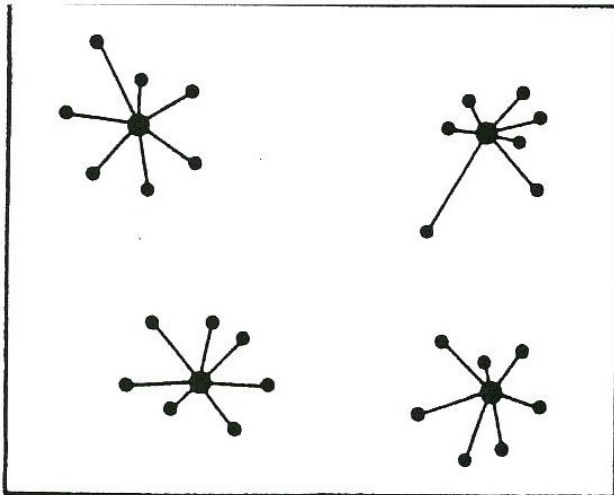


FIGURE 7 Stratified systematic sampling pattern.

Cluster Sampling

- Cluster Sampling selects points within a study area and uses each point as **a centre to determine locations of additional “satellite” observations** placed nearby, so that the overall distribution of observations forms a clustered pattern.



Cluster sampling may be efficient with respect to time and finance. If the pattern to be sampled is known beforehand, it may provide reasonably accurate results.

FIGURE 8 Clustered sampling pattern. Larger dots represent focal points for clusters selected randomly or possibly according to access or availability. Smaller dots represent satellite samples positioned at randomly selected distances and direction from the central point.

LOCATIONAL INFORMATION

- Identification of **Ground Control Points** (GCPs) which allow analysts to resample image data to provide accurate **planimetric location** and correctly match image detail to maps and other images.
- Often we would use points of a map (sayu road intersections) to geometrically correct an Image but in some cases we have to identify a feature on the image and go out and survey that point on the ground in order to get accutare geographci correction

GLOBAL POSITIONING SYSTEMS (GPS)

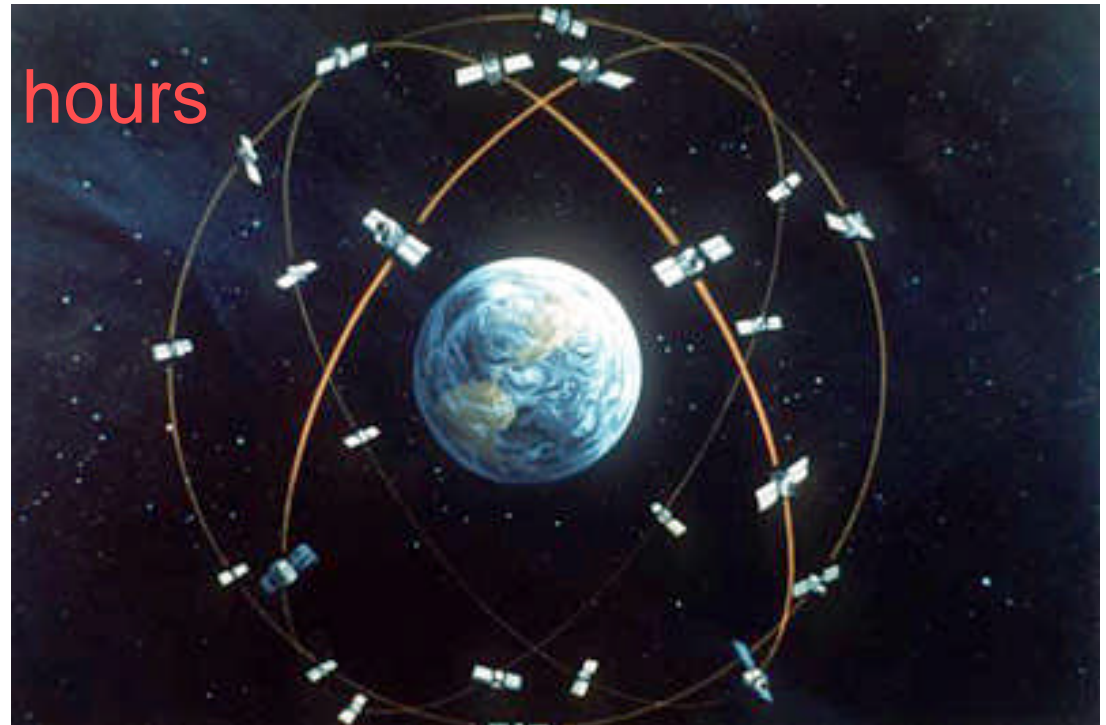
- Global Positioning Systems were originally developed by the US military. In recent years the availability of global positioning system (GPS) technology has permitted convenient, inexpensive and accurate measurement of absolute location. GPSs have greatly enhanced the usefulness of remote sensing data, especially when it is necessary to integrate image data with field data.

GLOBAL POSITIONING SYSTEMS (GPS)

- A GPS receiver consists of a portable receiving unit sensitive to signals transmitted by a network of earth-orbiting satellites.

These satellites are positioned in orbits such that each point on the earth's surface will be in the view of at least four and up to nine satellites at a given time.

1. A system of **24 satellites** at an altitude of **17,600km**
2. Circle the earth in **12 hours**



GLOBAL POSITIONING SYSTEMS (GPS)

- Satellites continuously broadcast one-way signals at two frequencies within the L-band region of the microwave spectrum.
- These signals permit GPS receivers to solve equations to estimate latitude longitude and elevation.
- Both L-band signals are modulated to carry a precision code P-code; one of the two bands, however, also carries a coarse acquisition code (C/A) that provides less precise information.

GPS Receivers

- A GPS receiver consists of an antenna, power supply, electric clock and circuitry that can translate the signal into positional information..
- Four channels are required, at a minimum, for highly accurate scientific or navigational applications (three channels for positional information and a fourth to ensure that timing information is correct). Most everyday remote sensing applications can be satisfied by the more modest capabilities of two-channel GPS receivers.
- GPS signals can be used in several ways to estimate location-two of the most important are pseudo-ranging and carrier phase measurement.

HOW GPS WORKS

How GPS works

- (1) **Satellite Trilateration**- the basis of the system.
- (2) **Satellite Ranging**- measuring distance from a satellite.
- (3) **Accurate Timing**- why consistent clocks and a fourth space vehicle are needed.
- (4) **Satellite Positioning**- knowing where a satellite is in space.
- (5) **Correcting Errors**- correcting for ionospheric and tropospheric delays.

Satellite Trilateration.

- Exact coordinates can be calculated for any position on earth by measuring the distance from a group of satellites to the position. The satellites act as precise reference points. Assuming the distance from one satellite is known, the position can be narrowed down to the surface of a sphere surrounding that satellite.

Satellite Trilateration.

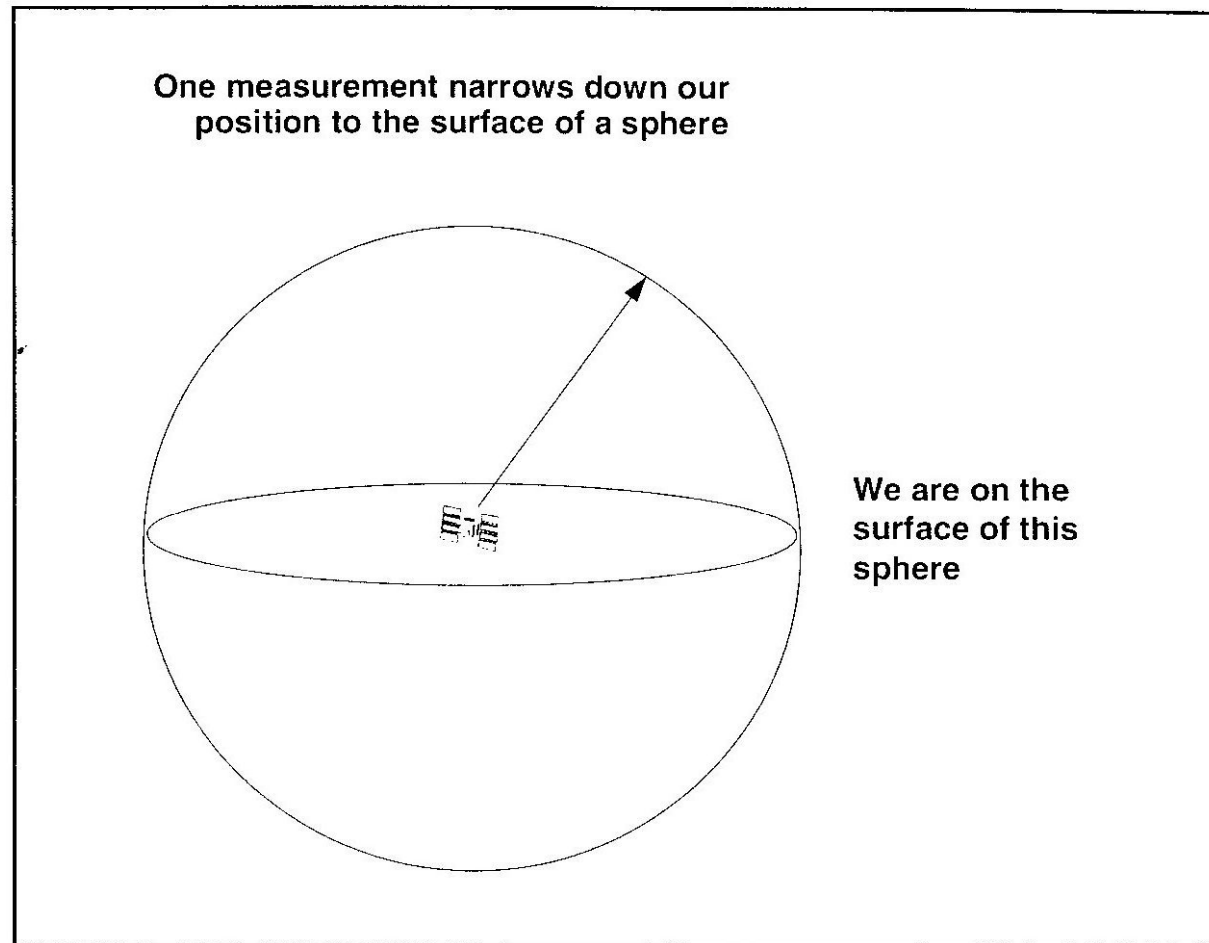


Figure 11 One Satellite

Satellite Trilateration.

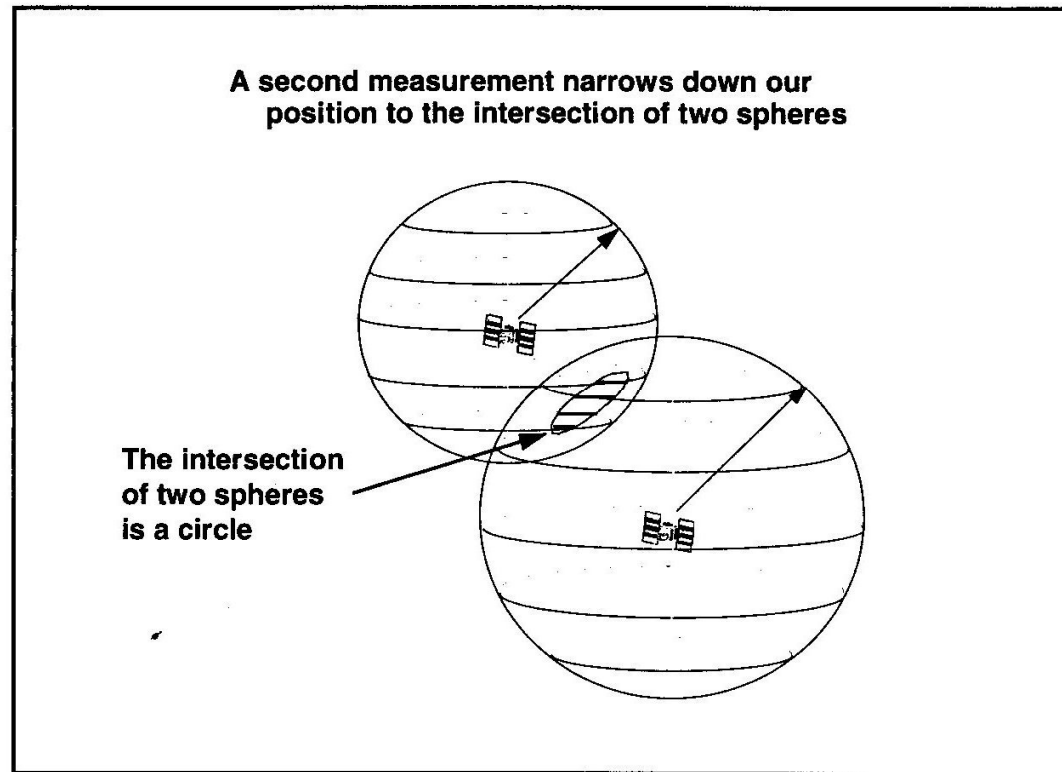


Figure 12 Two Satellites

Satellite Trilateration.

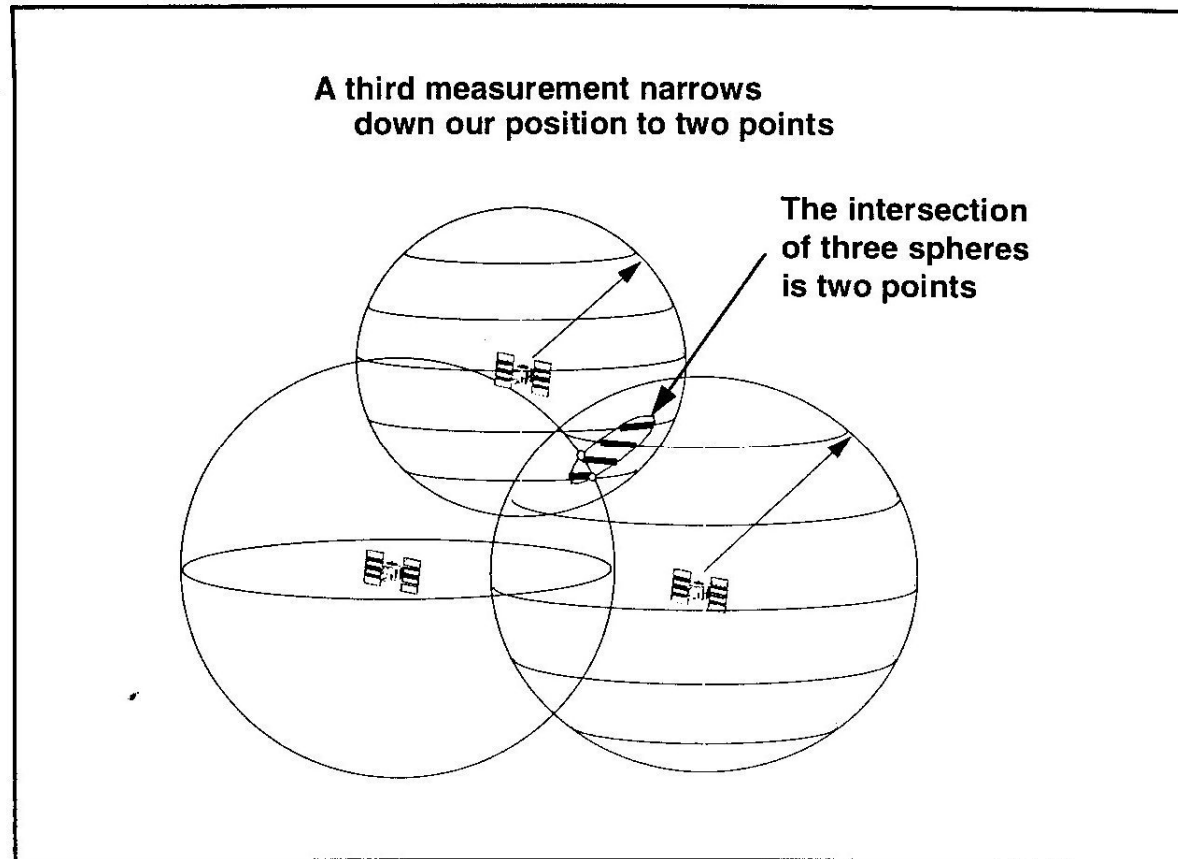


Figure 13 Three Satellites

Satellite Ranging.

- The receiver examines the incoming code from the satellite and then looks at how long ago it generated the same code. This time difference is multiplied by the speed of light (186,000 miles/second) to give distance.
- The use of a code is important because it allows the receiver to make the comparison at any time. It also means that the satellites can operate at the same frequency, because each satellite is identified by its own PseudoRandom Number (PRN) code.

Local Differential GPS

- When a GPS receiver can be stationed at a fixed position of known location, it becomes possible to derive estimates of errors and to apply these estimates to improve the accuracy of GPS location of points at unknown locations. This process is known as local differential GPS
- Differential GPS requires that a GPS receiver be established at a fixed point for which the geographic location is known with confidence-this location forms the base station. In Irelands case this is provided by the commisioner of irish lights.
- Information from the base station can be applied to locational information from roving GPS receivers to derive more accurate estimates of location.
- Atmospheric effects constitute one of the major sources of error in GPS measurements. Electrically charged particles in the ionosphere (30-300miles above the earth's surface) and severe weather in the troposphere (ground to 7.5miles) can combine to cause errors of 1-5ms. Topographic location, presence of structures and nearby vegetation canopies also can contribute to variations in effective use of GPS receivers.

GLOBAL POSITIONING SYSTEMS (GPS)



RTK

- A real time correction for error: Real Time Kinematics
- Service supplied by OSI using Phone Network linked to RINEX stations
- Need GPS linked to mobile phone-pay for call.
- Can post-process with data from OSI website for free
- Compares carrier signal instead of code

Tips

- Always check for satellite availability before going out on field trip
- If it's been a while since last using your GPS, allow for ephemeris data to be downloaded before taking points
- Be aware of topography and location- coverage gets worse the further north you are. In the northern hemisphere coverage is bad on steep northern slopes.
- Poor coverage in forests, especially wet ones!
- Poor GPS in cities unless using satnav that uses alternative location sources
- Your body is an effective microwave shield- face south when taking a measurement
- Check the batteries!

- Additional information from:
- http://europa.eu.int/comm/space/index_en.html
- http://europa.eu.int/comm/dgs/energy_transport/galileo/
- <http://www.galileoju.com>
- <http://www.esa.int/esaNA/galileo.html>
- <http://www.osi.ie/wp-content/uploads/2015/07/Survey-Ireland-2004-GPS-Network-RTK-Solution-for-Ireland.pdf?ext=.pdf>

Accuracy Assessment

We may *define* accuracy, in a working sense, as *the degree of correspondence between observation and reality*. We usually judge accuracy against existing maps, large scale aerial photos, or field checks. We can pose two fundamental questions about accuracy:

Is each category in a classification really present at the points specified on a map?

Are the boundaries separating categories valid as located?

Various types of errors diminish the accuracy of feature identification and category distribution. We make most of the errors either in measuring or in sampling. When quantifying accuracy, we must adjust for the lack of equivalence and totality, if possible. Another, often overlooked point about maps as reference standards, concerns their intrinsic or absolute accuracy. Maps require an independent frame of reference to establish their own validity.

As a general rule, the level of accuracy obtainable in a remote sensing classification depends on diverse factors, such as the suitability of training sites, the size, shape, distribution, and frequency of occurrence of individual areas assigned to each class, the sensor performance and resolution, and the methods involved in classifying (visual photointerpreting versus computer-aided statistical classifying), and others

In practice, we may test classification accuracy in four ways:

1) field checks at selected points (usually non-rigorous and subjective), chosen either at random or along a grid;

2) estimate (non-rigorous) the agreement of the theme or class identity between a class map and reference maps, determined usually by overlaying one on the other(s);

3) statistical analysis (rigorous) of numerical data developed in sampling, measuring, and processing data, using tests, such as root mean square, standard error, analysis of variance, correlation coefficients, linear or multiple regression analysis, and Chi-square testing .

4) confusion matrix calculations (rigorous).

With the class identities in the photo as the standard, we arranged the number of pixels correctly assigned to each class and those misassigned to other classes in the confusion matrix , listing errors of commission, omission, and overall accuracies.

The producer's accuracy relates to the probability that a reference sample (photo-interpreted land cover class in this project) will be correctly mapped and measures the errors of omission ($1 - \text{producer's accuracy}$).

In contrast, the user's accuracy indicates the probability that a sample from land cover map actually matches what it is from the reference data (photo-interpreted land cover class in this project) and measures the error of commission ($1 - \text{user's accuracy}$).

Errors of *commission* An error of commission results when a pixel is committed to an incorrect class

.

Errors of *omission* An error of omission results when a pixel is incorrectly classified into another category. The pixel is omitted from its correct class.



w2.mxd - ArcMap

1:213,246

Editor

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

Classification curragh17.tif

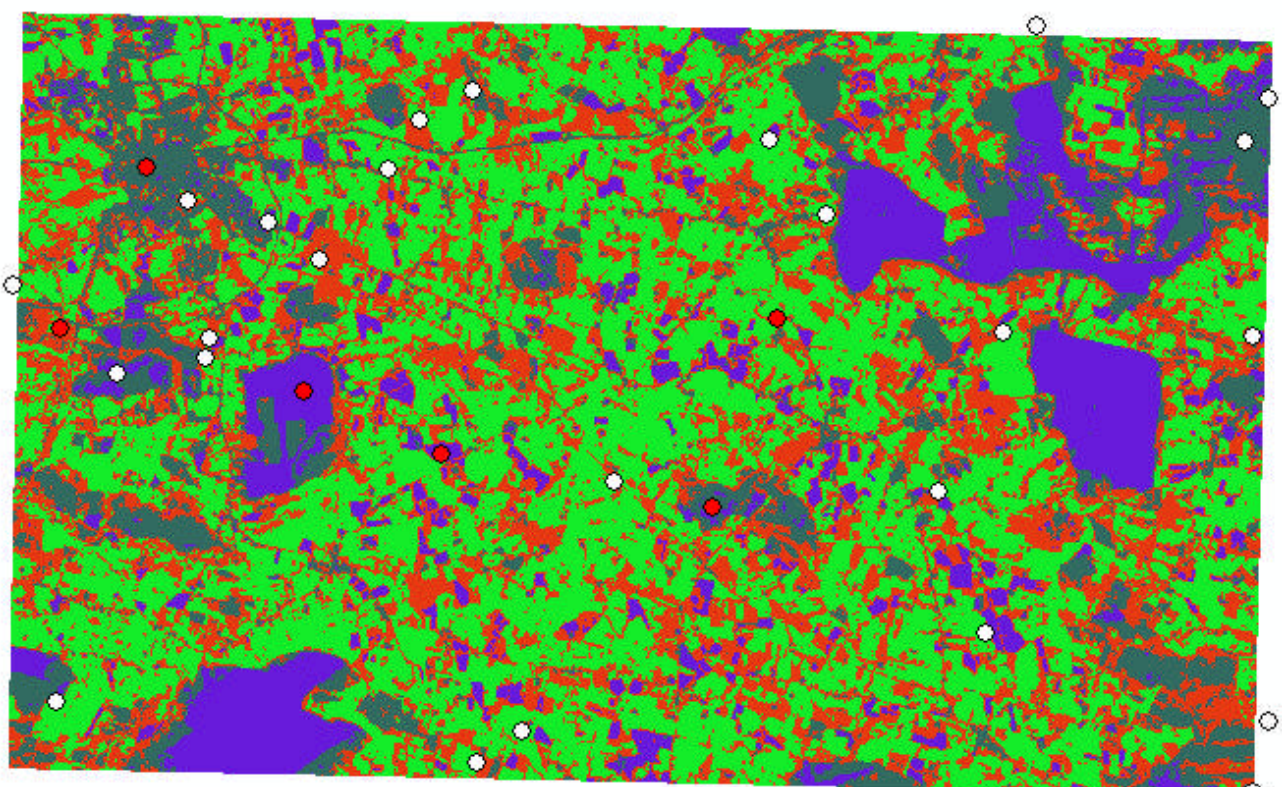


Table Of Contents

Layers

- \\nfx341\homeshar...
- point
- isocluster1
 - 1
 - 2
 - 3
 - 4
- D:\
- sites
 -
- D:\
- curragh17.tif
 - RGB
 - Red: Band_5
 - Green: Band_4
 - Blue: Band_3
 - curragh17
 - RGB
 - Red: curragh:

-807789.539 7035835.903 Meters

| | urban | grass | natural | water | forestry | map | |
|----------|-------|-------|---------|-------|----------|-----|-----|
| urban | 12 | 5 | 1 | 6 | 7 | | 31 |
| grass | 1 | 34 | 7 | | 2 | | 44 |
| natural | 2 | 9 | 23 | | 6 | | 40 |
| water | | | | 14 | 2 | | 16 |
| forestry | | | | 4 | 20 | | 24 |
| ground | | | | | | | |
| | 15 | 48 | 31 | 24 | 37 | | 155 |

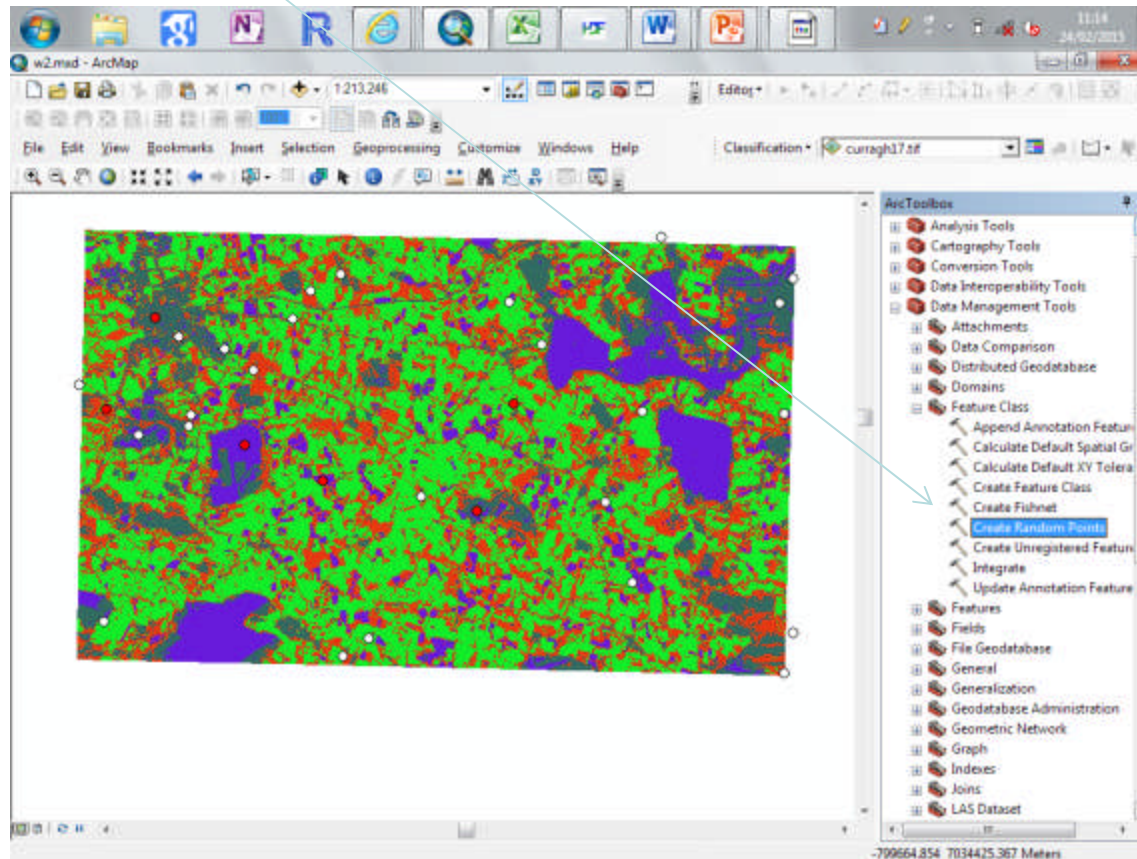
Urban Comission $(15-12)/15 = 25\%$
 So users accuracy is 75%

Urban Ommission: $(31-12)/31 = 61\%$
 So Producers accuracy is: 39%

Total mapp accuray is $(12+34+23+14+20)/155 = 66\%$

Assessing your map

Once you are happy with your supervised map, load into arcMap and use the create random points tool



Create Random Points

Output Location
\\nfx341\homeshares3\$\stuart.green\ArcGIS\Default.gdb

Output Point Feature Class
testpoint

Constraining Feature Class (optional)

Constraining Extent (optional)
Same as layer curragh17.tif

Top
7038636.798009

Left
-838563.204631

Right
-802255.569728

Bottom
7016107.825635

Clear

Number of Points [value or field] (optional)
 Long
25

Field

Minimum Allowed Distance [value or field] (optional)
 Linear unit
0 Meters

Field

Create Multipoint Output (optional)

OK Cancel Environments... << Hide Help

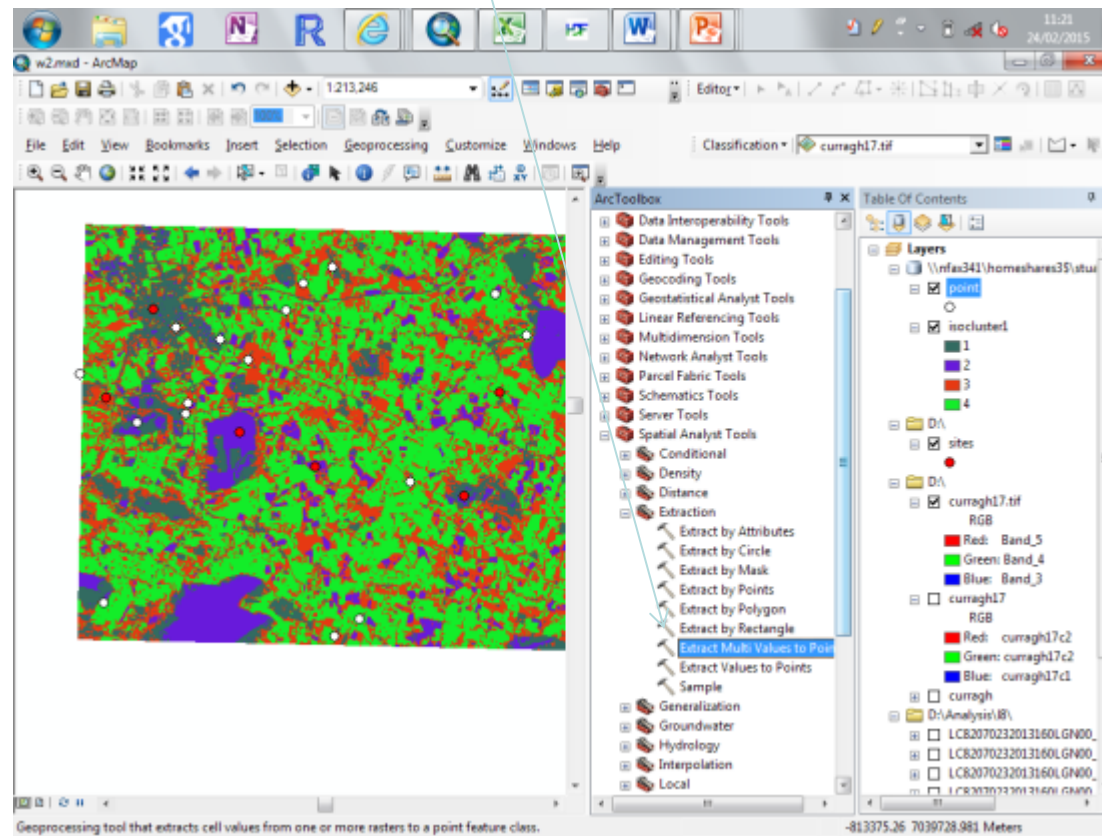
Add output name

Constrain to Curragh17.tif

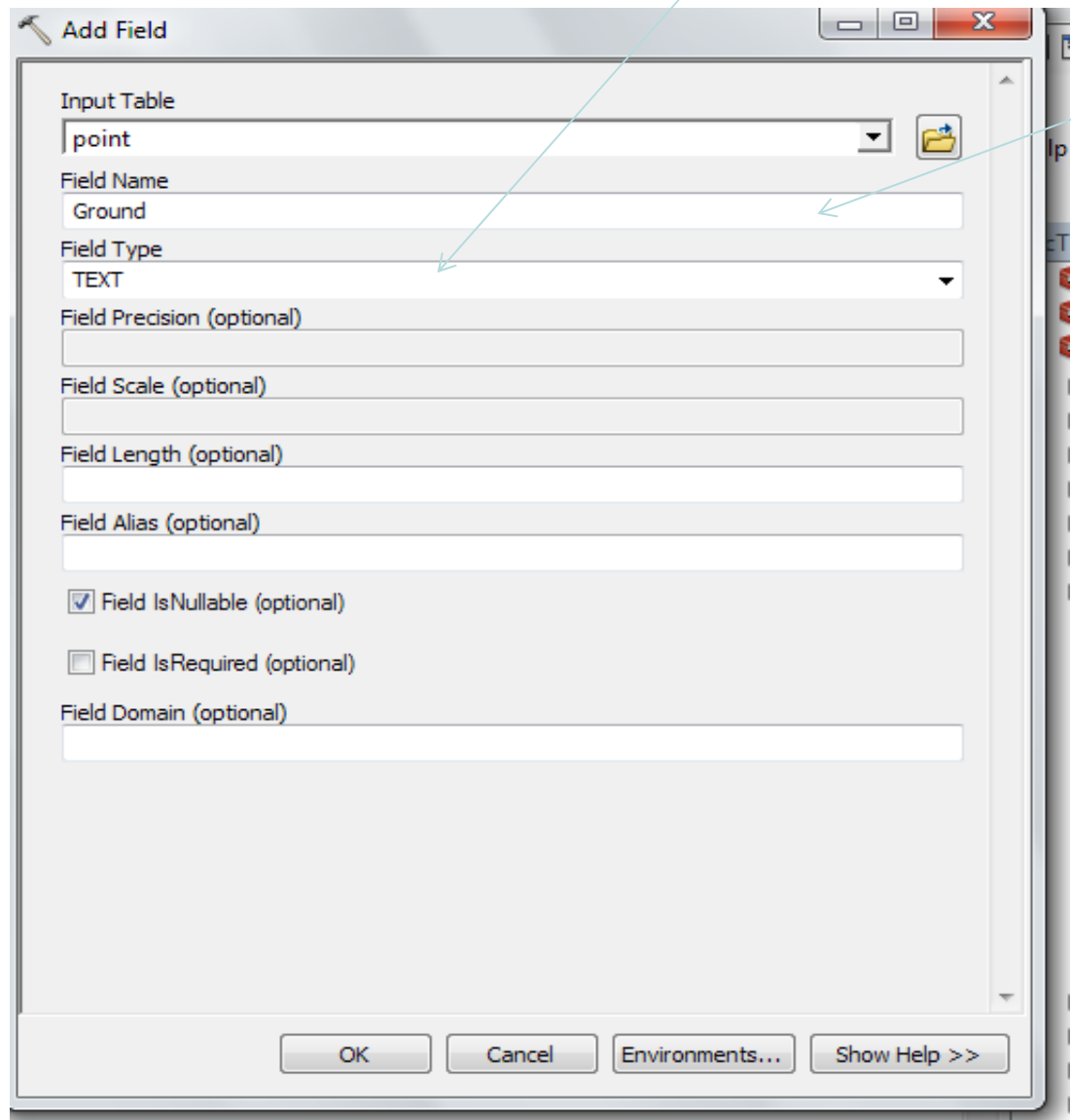
Create 25 points

Click OK

Use the Extract Multivalues to point tool to assign the value of your map to each point
In your test point coverage



Use the “add field” tool to create an extra text field in your testpoints coverage called “Gro



Right Click on the testpoints field in Table of contents and click edit-start edit

Open up the attribute table for the test points coverage and you can now edit the “Ground Field”

Now simply zoom to each point in turn and record in the “ground field” the landcov class visible in the “base image” airphotos.

To create the error matrix, Use Data Management Tools->Tables->Pivot Tables