# Geographic Phenomena - Concepts and Examples

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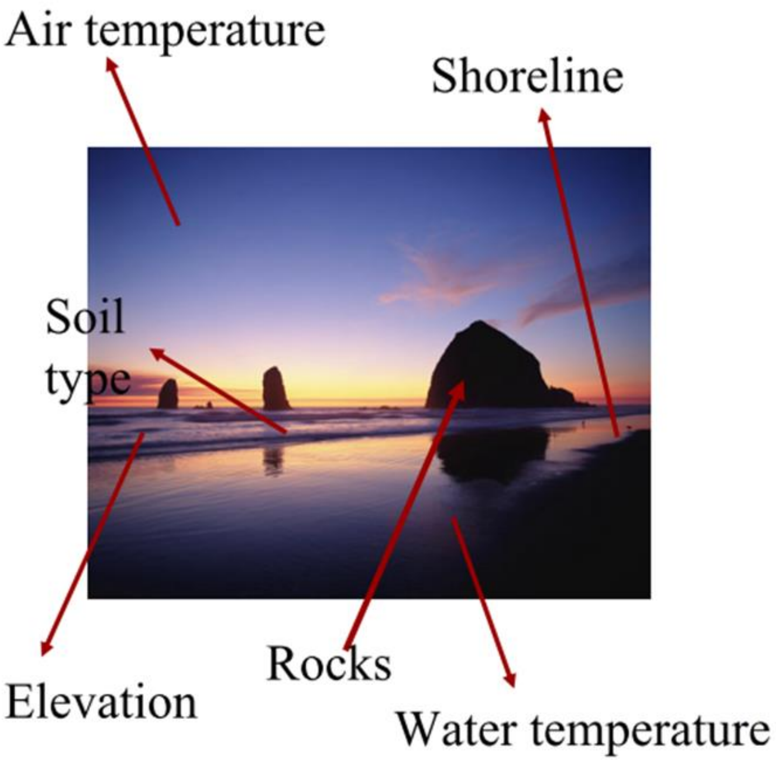
***Credits:*** *ITC - The Netherlands, Burrough, Chang, Maidment and Google!*

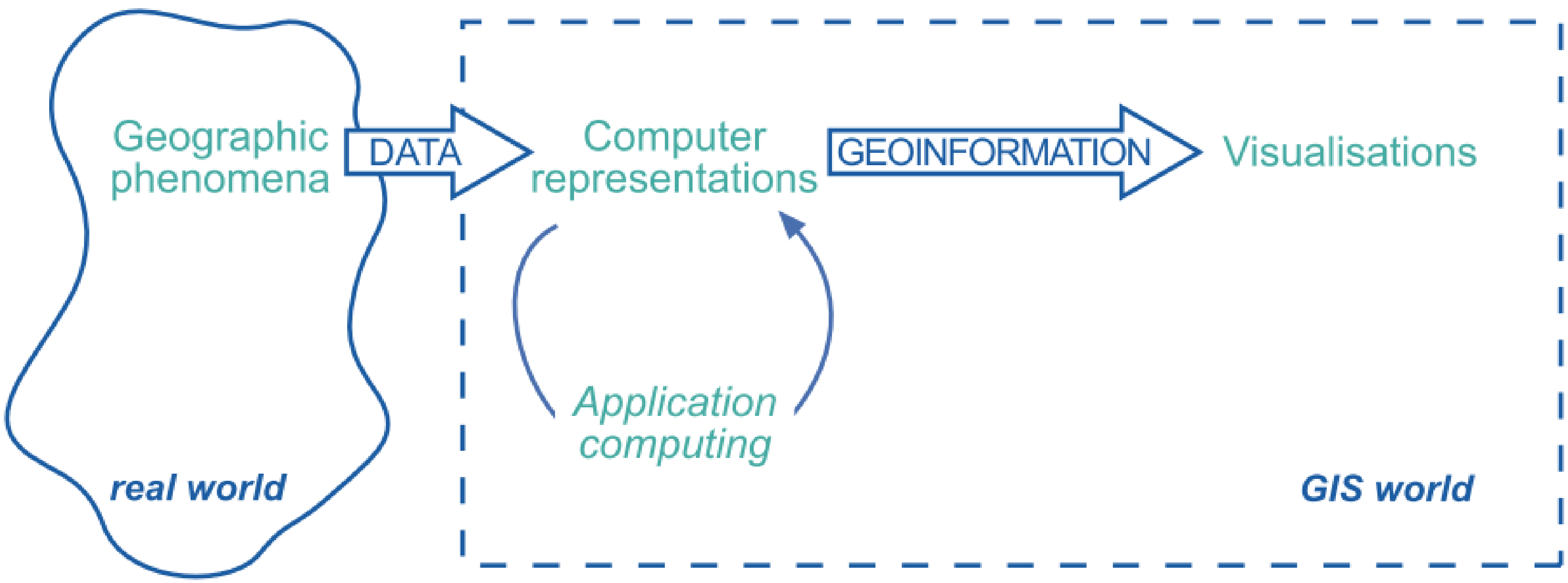
# Introduction

- Geographic phenomena are the study objects of a GIS.
- Geographic phenomena exist in the real world, everything you see outside is a Geographic phenomenon.
- Some of the things you do not see are also Geographic phenomena like temperature.



# Real world → Spatial data

- Data model represents the linkages between the real world domain of geographic data and the computer or GIS representation of these features (*Marble et al, 1982*).



# Geographic phenomena

- A geographic phenomenon is a manifestation of an entity or process of interest that:
  - Can be **named** or described
  - Can be **geo-referenced**
  - Can be assigned a **time** interval at which it is/was present (optional)


**Description:** IIRS Main Building

**Location:** 30°20'27.1"N 78°02'39.0"E

**Established in:** 1966

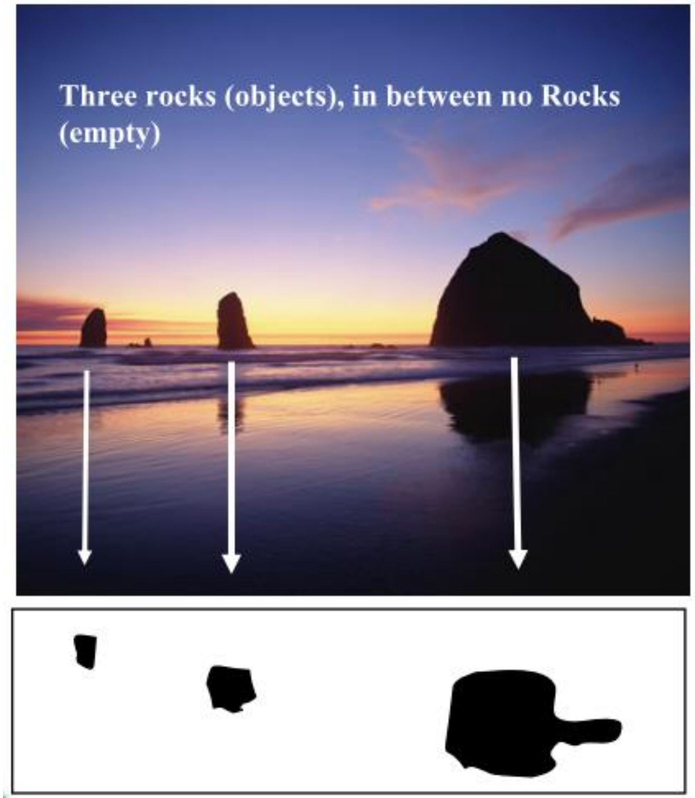
**Departments:** 10

# Types of Geographic Phenomena

- A (geographic) **field** is a geographic phenomenon for which, for every point in the study area, a value can be determined. (temperature, pressure and elevation)
- A (geographic) **object** is a geographic phenomenon that does not cover the total study area, the space in between objects is potentially empty or undetermined. (buildings, rivers)

# Objects

- Example: Building
- Characteristics:
  - Crisp boundaries
  - Inside the boundary only one value




# Field

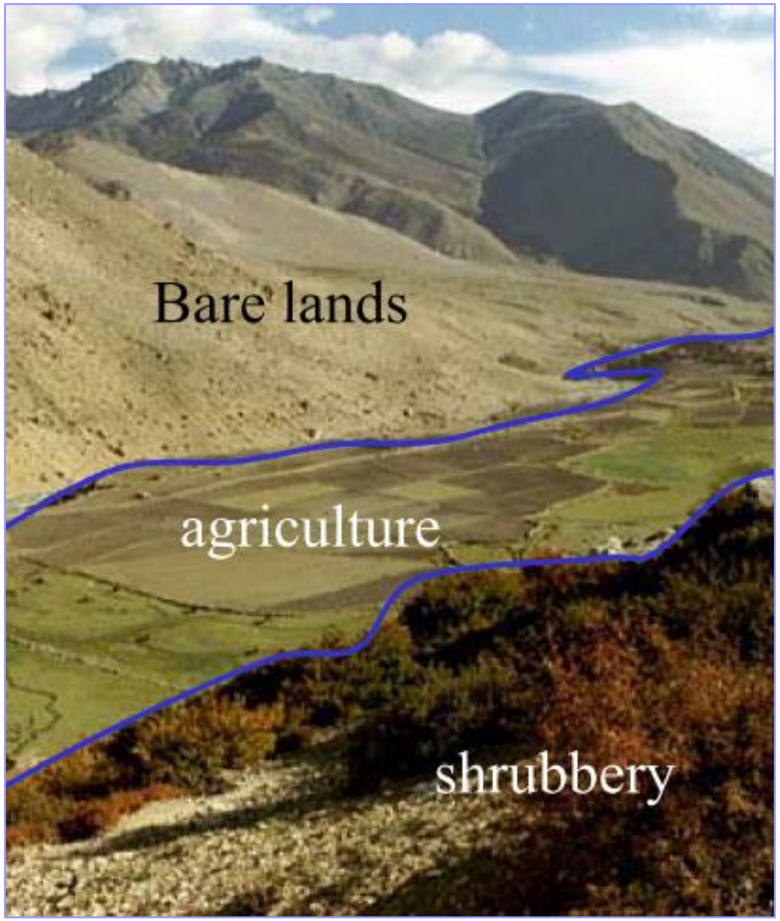
- Examples:
  - Temperature
  - Barometric Pressure
  - Elevation
- Characteristics:
  - On the image on the right you can measure elevation (height) everywhere

# Field (Continuous)

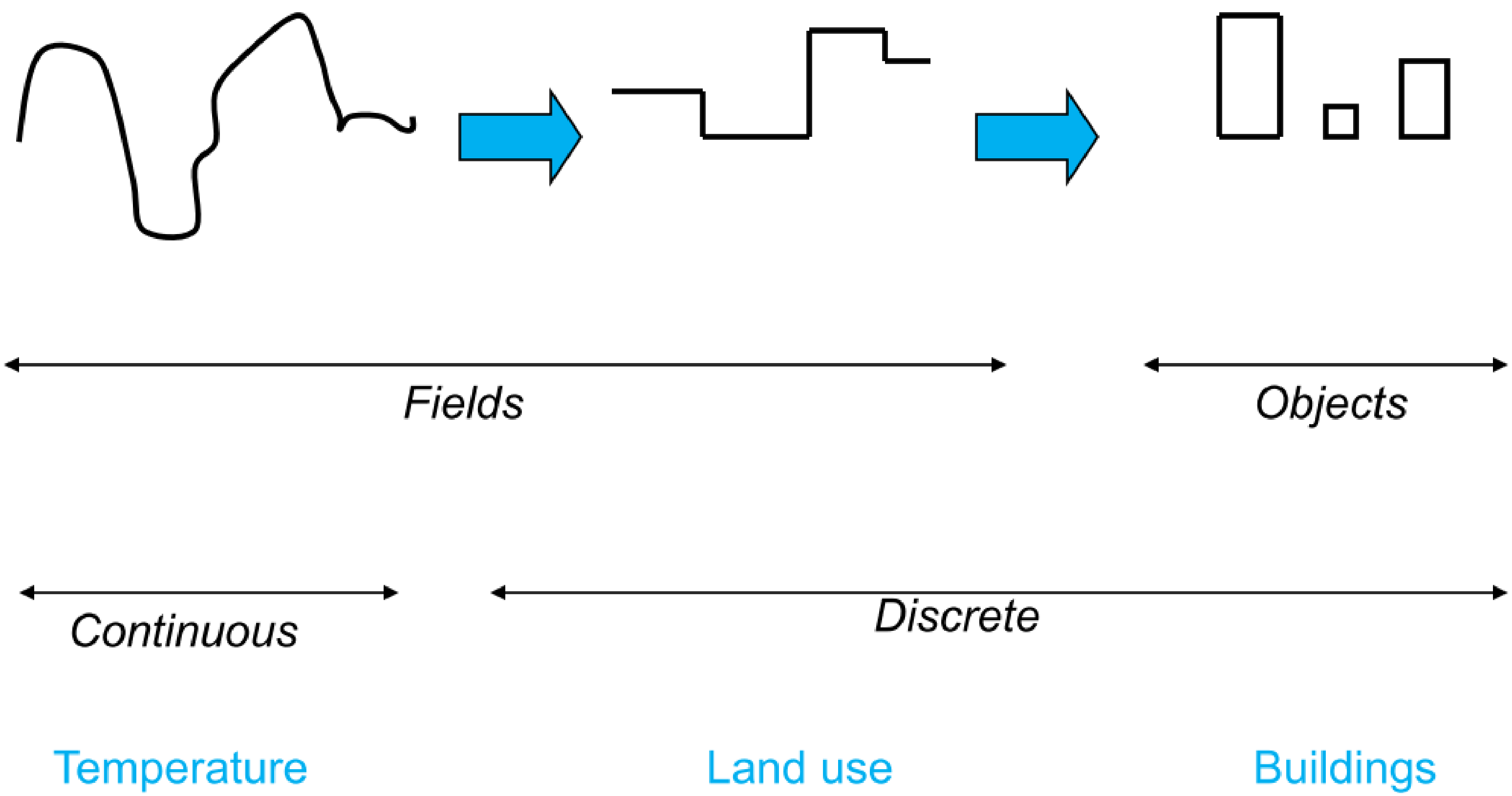
- Continuous means that all changes in field values are gradual
- In a differentiable field we can measure the change.
- In the example on the right, we can measure the gradient (slope) as the change of elevation.

# Field (Discrete)

- Discrete fields cut up the study space in subparts with a clear boundary, with all locations in one part having the same value
- Typical examples are land classifications, geological classes, soil types, landuse types, crop types or natural vegetation types

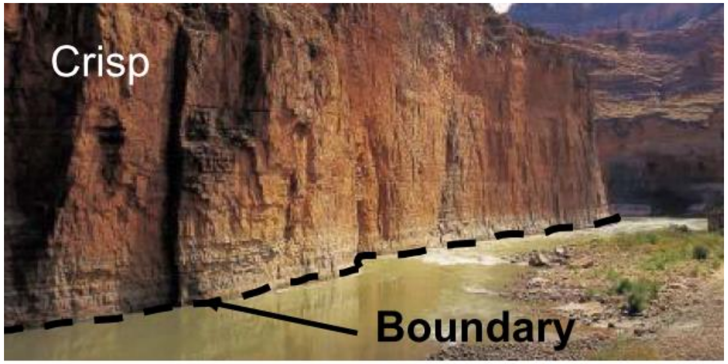


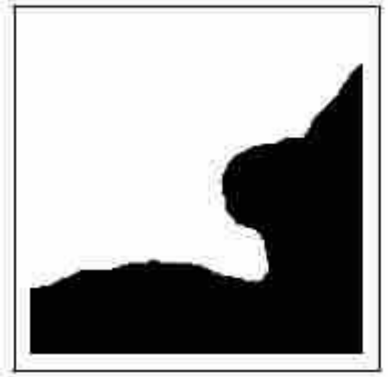
# Types of Geographic Phenomena

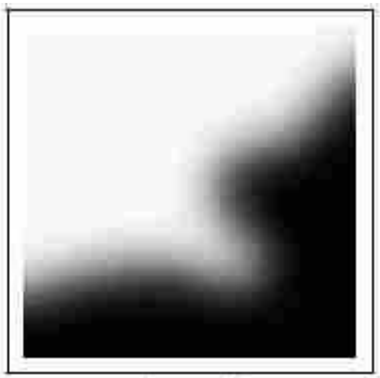


# Boundaries

- Both <u>objects</u> and <u>discrete fields</u> have boundaries
- Two different types of boundaries
  - **Crisp** boundaries
  - **Fuzzy** boundaries





# Summary geographic phenomena

| | Coverage | Boundaries | Type of boundaries | Characteristics |
|---|---|---|---|---|
| **Continuous field** | Cover the total space | Have no boundaries | | |
| **Discrete field** | Cover total space | Have boundaries | Crisp or fuzzy | |
| **Collection of Objects** | Have gaps in between | Have boundaries | Crisp or fuzzy | Have a location, size, orientation, shape |

Quiz time!

**Login through your mobile's browser**

**Quiz will start at the end of this lecture**

**Lecture will resume in 2 mins**

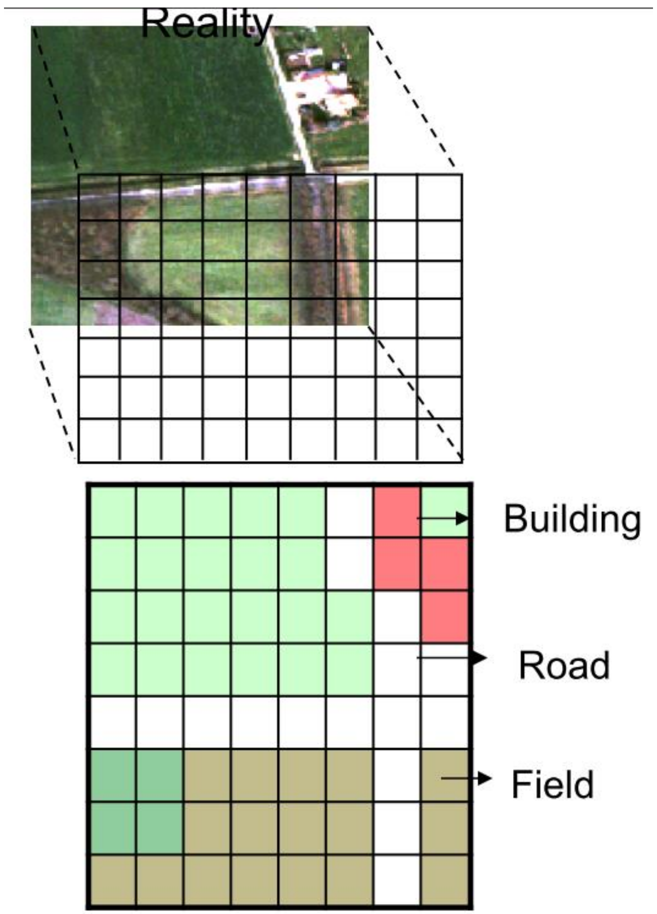
# https://tale.tn/7sW5Y1

# Computer representation

- So far we only discussed geographic phenomena, in the following slides we discuss computer representation.
- Computer representation can be divided in two groups:
  - Tessellations
  - Vector based representation
- Now we will see how computer representations can be applied to represent geographic fields and objects.

# Tessellation (Regular)

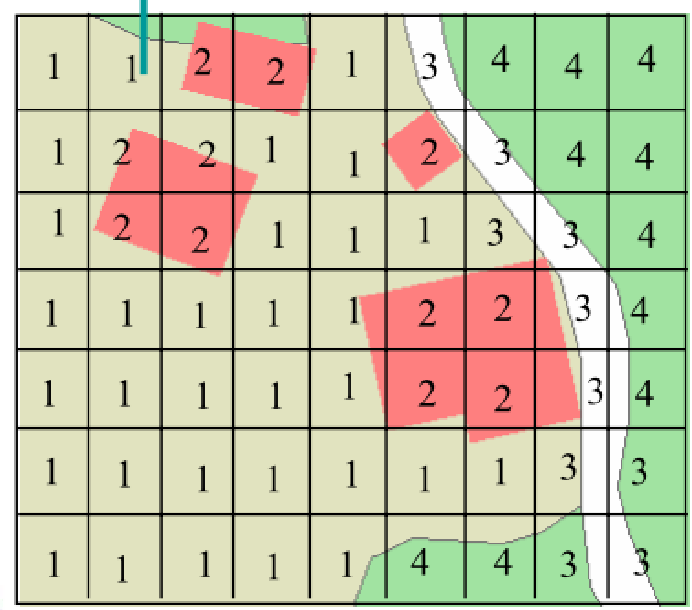
- A tessellation is a partitioning of space into mutually exclusive cells that together make up the complete study area.
- The cells are of the same shape and size, and the field attribute value assigned to a cell is associated with the entire area occupied by the cell.



# Tessellation (Regular)

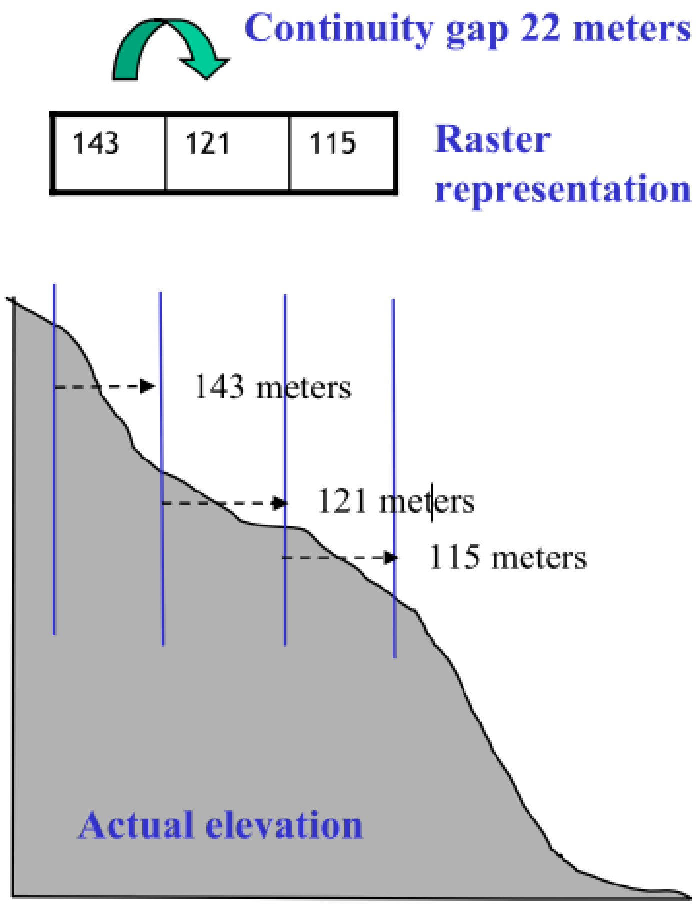
- The size of the area that a single raster cell represents is called the raster's *resolution.*

Each cell represents an area of 10 by 10 meters, the resolution is 10x10 meter



# Tessellation (Regular)

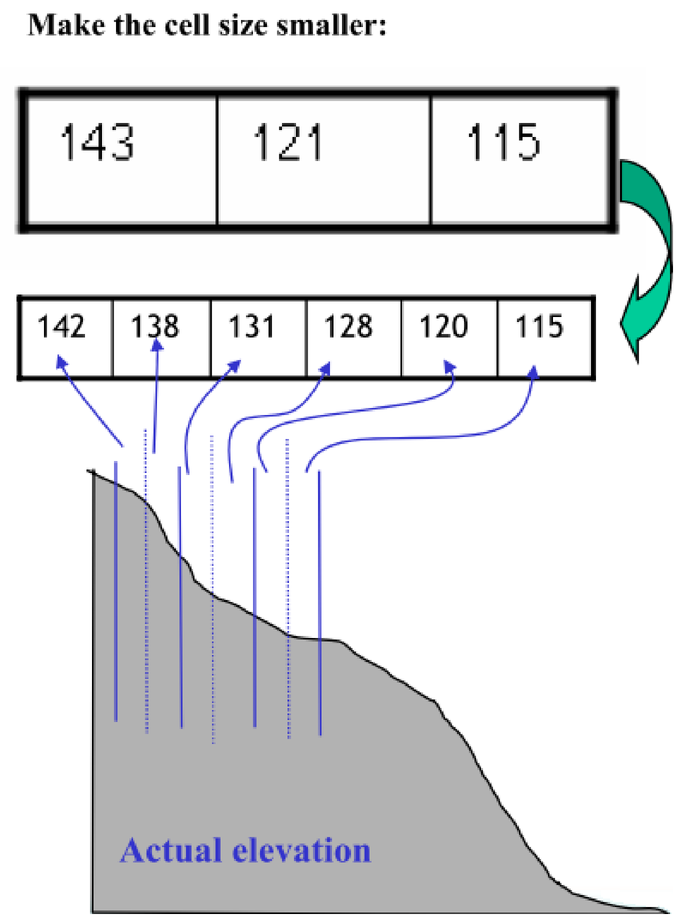
- When we represent a continuous field, values are changing constantly
- In a regular tessellation each cell has only one value, that represents the total area of a cell (average elevation)
- There will be a continuity gap between adjacent cells



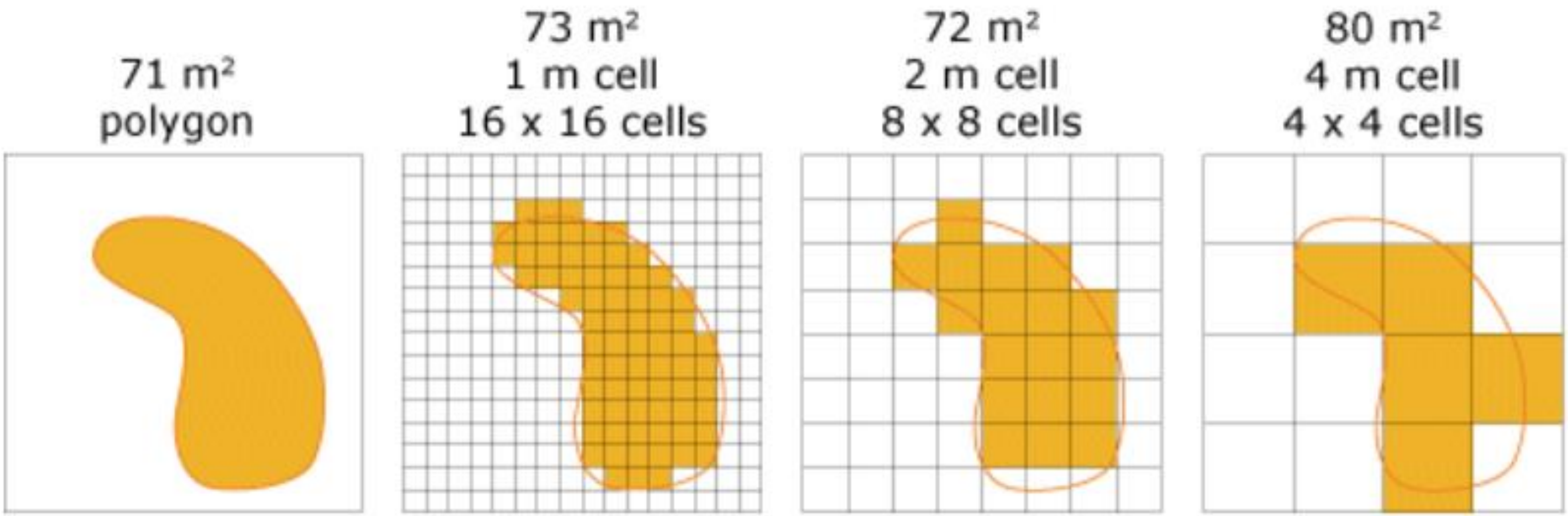
# Tessellation (Regular)

- Two ways to improve on this continuity issue:

1. Make the cell size smaller
2. Assume that the cell value only represents one specific location and provide a good interpolation function for all other locations



# Cell size



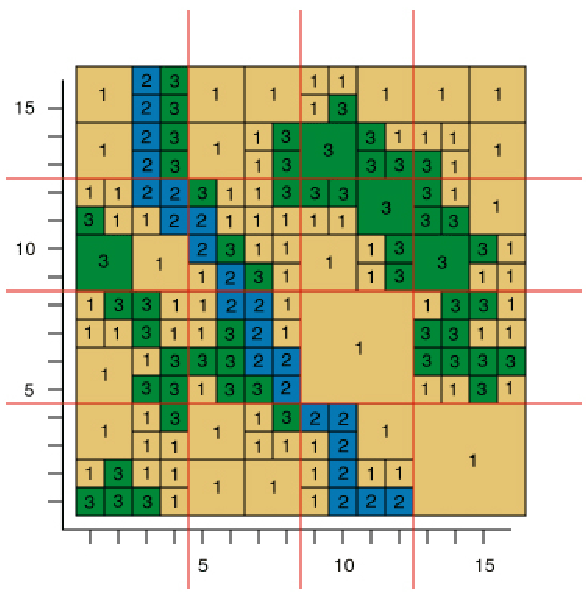

- **Smaller cell size**
- **Higher resolution**
- **Higher feature spatial accuracy**
- **Slower display**
- **Slower processing**
- **Larger file size**

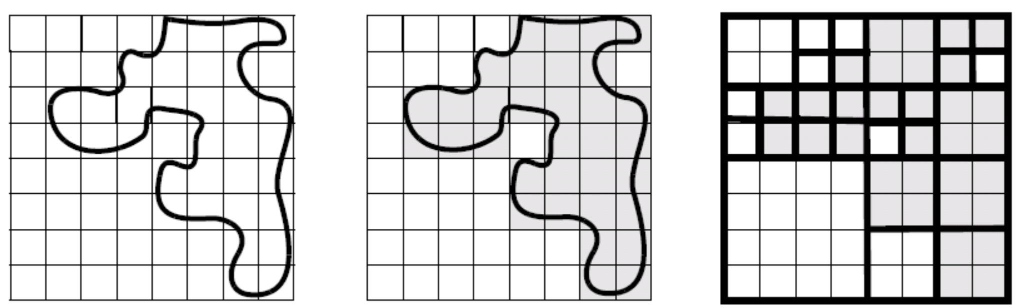
- **Larger cell size**
- **Lower resolution**
- **Lower feature spatial accuracy**
- **Faster display**
- **Faster processing**
- **Smaller file size**

***Source:*** *http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/Cell_size_of_raster_data/009t00000004000000/*

# Tessellation (Irregular)

- Irregular tessellations are again partitions of space into mutually exclusive cells, but now the cells vary in size and shape, allowing them to adapt to the spatial phenomena they represent.
- Example: Quadtrees, Run length encoding



# Vector based - Point (0-D)

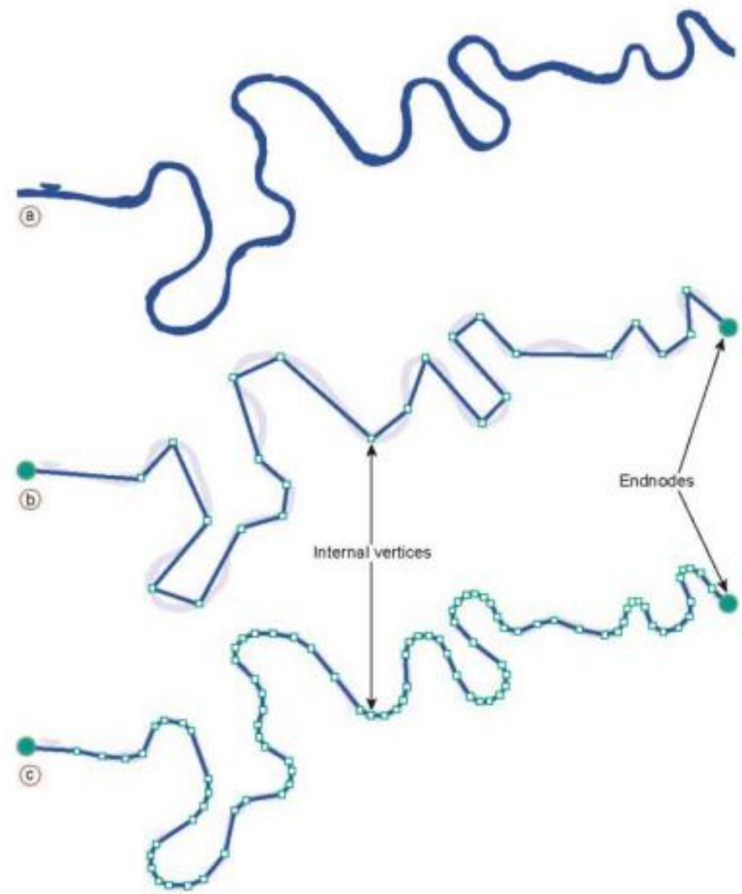
- Points are defined as single coordinate pairs (x,y) when we work in 2D or coordinate triplets (x,y,z) when we work in 3D
- Points are used to represent objects, that are shape- and size less (zero-dimensional)
- Examples:
  - Cities on India Map
  - Schools on Dehradun Map

# Vector - Line (1-D)

- Used to represent one-dimensional objects (roads, railroads, canals, rivers…)
- Line is defined by 2 end nodes and 0-n internal nodes.
- An internal node or vertex is like a point that only serves to define the line
- Many GISs store a line as a sequence of coordinates of its end nodes and vertices, assuming that all its line segments are straight.

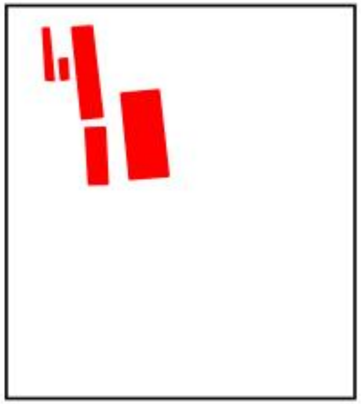
# Line (2)

- By increasing the number of internal vertices, we can improve the shape.
- Number of vertices determines the precision.
- Scale is related to the spatial accuracy - lower number of internal vertices - coarse scale - generalization.



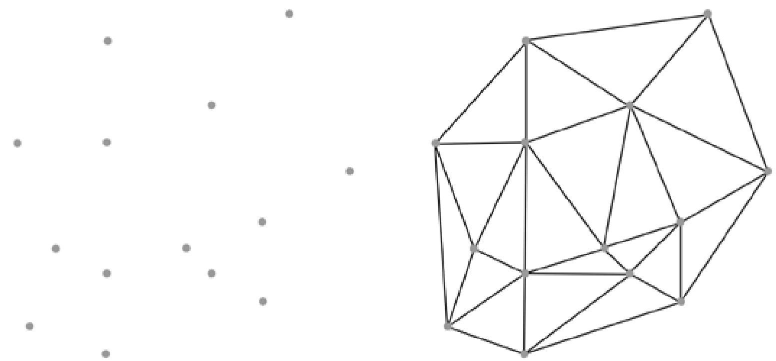
# Vector - Area (Polygon) (2-D)

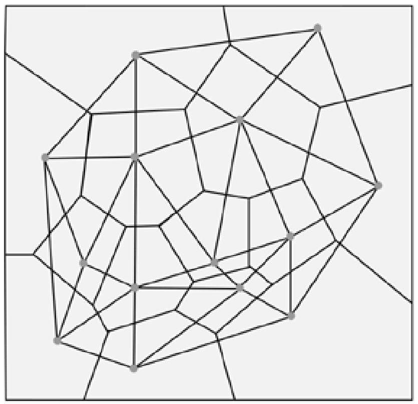
- When area objects are stored using a vector approach, the usual technique is to apply a boundary model.
- This means that each area feature is represented by some arc/node structure that determines a polygon as the area's boundary.
- Area features of the same type are stored in a single data layer, represented by mutually non-overlapping polygons.



# Triangulated Irregular Networks

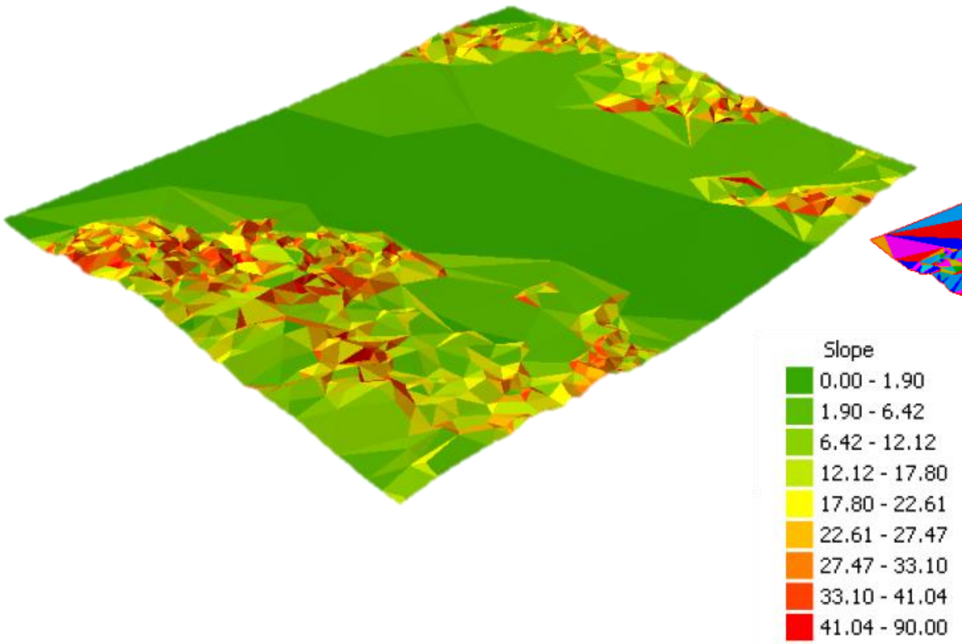
- A **vector-based** representation of a surface
- Commonly used in applications that involve **terrain**
- Composed of a series of contiguous, non-overlapping **triangles** that are known as faces
- Built from a series of points using a technique called **Delaunay** triangulation
- Advantages: More **efficient** at storing data
- Also used to construct **Thiessen** polygons, which form the basis for **interpolating** to areas.

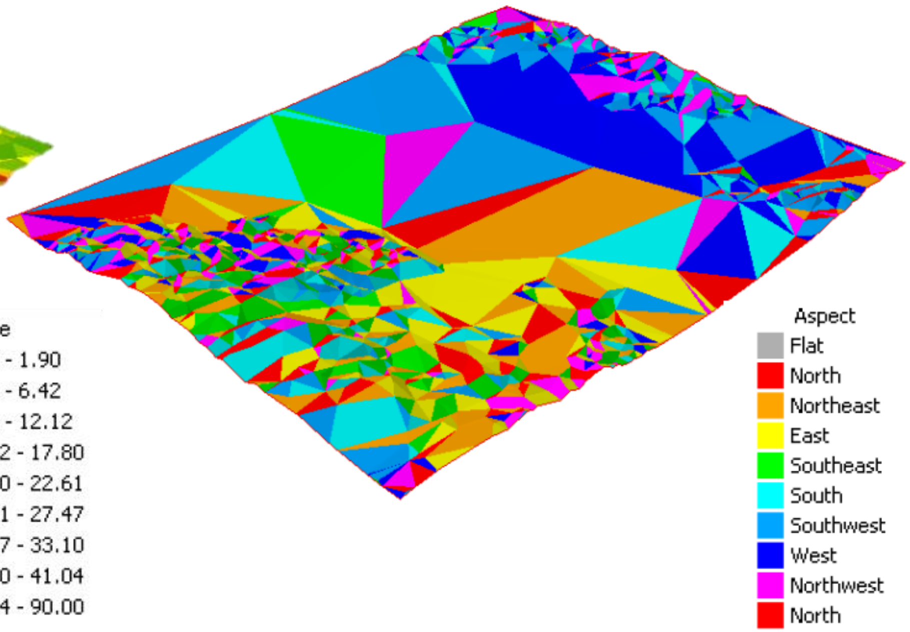




# TIN (Examples)

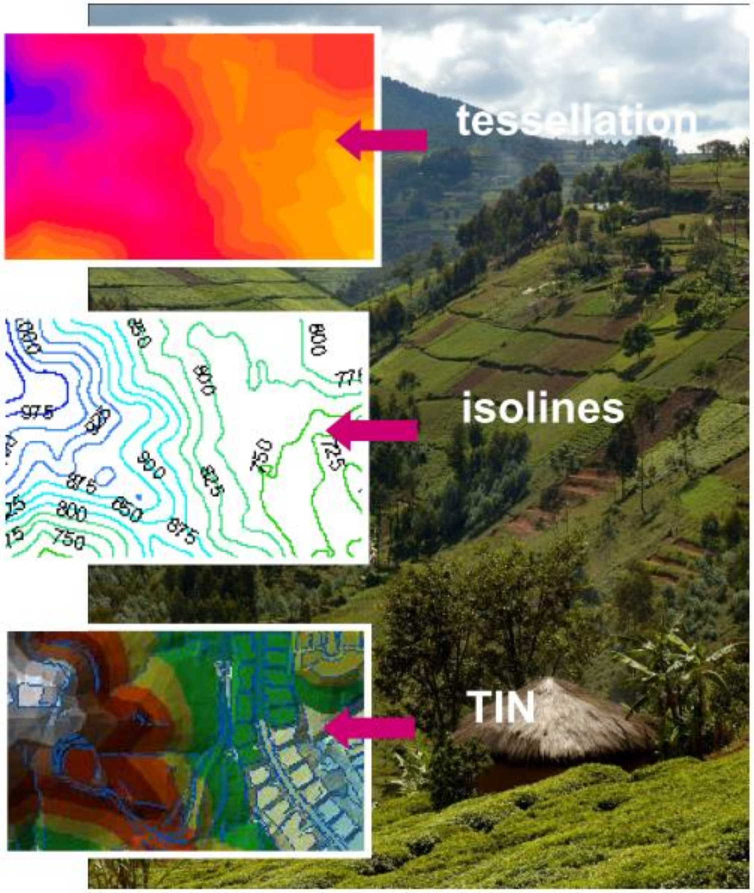
- SLOPE
- ASPECT



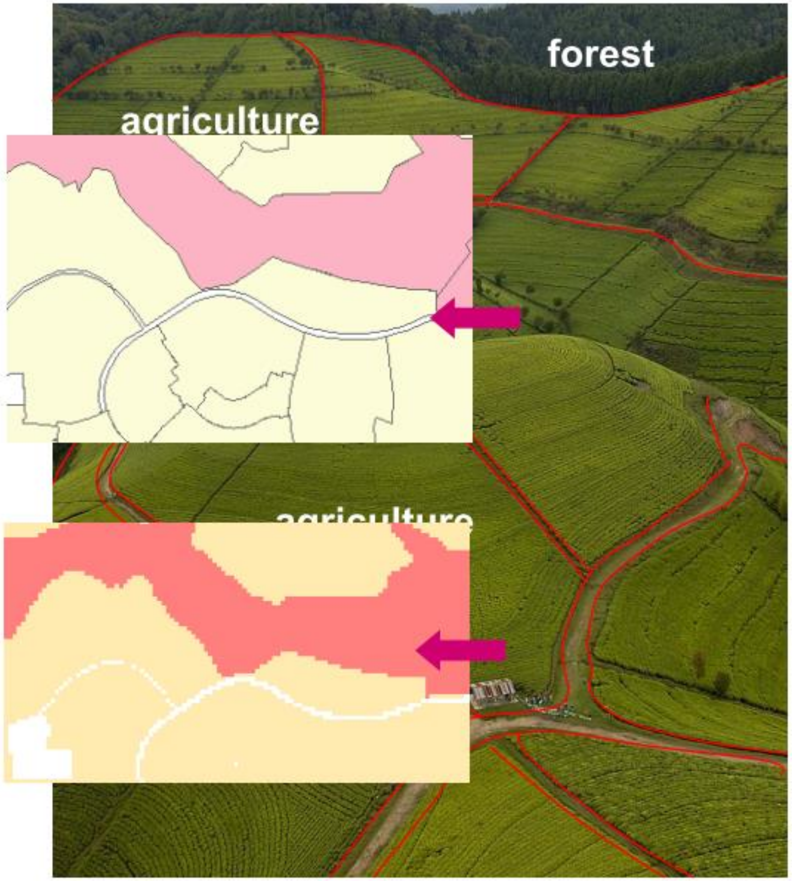
# REPRESENTATIONS OF GEOGRAPHIC FIELDS (CONTINUOUS)

- Continuous fields (like elevation) can be represented as:
  - Raster (DEM)
  - Vector (Contour Lines)
  - TIN
- Continuous fields when represented as a tessellation may lead to floating point cell values
- Both tessellation and TIN can be regarded as surfaces



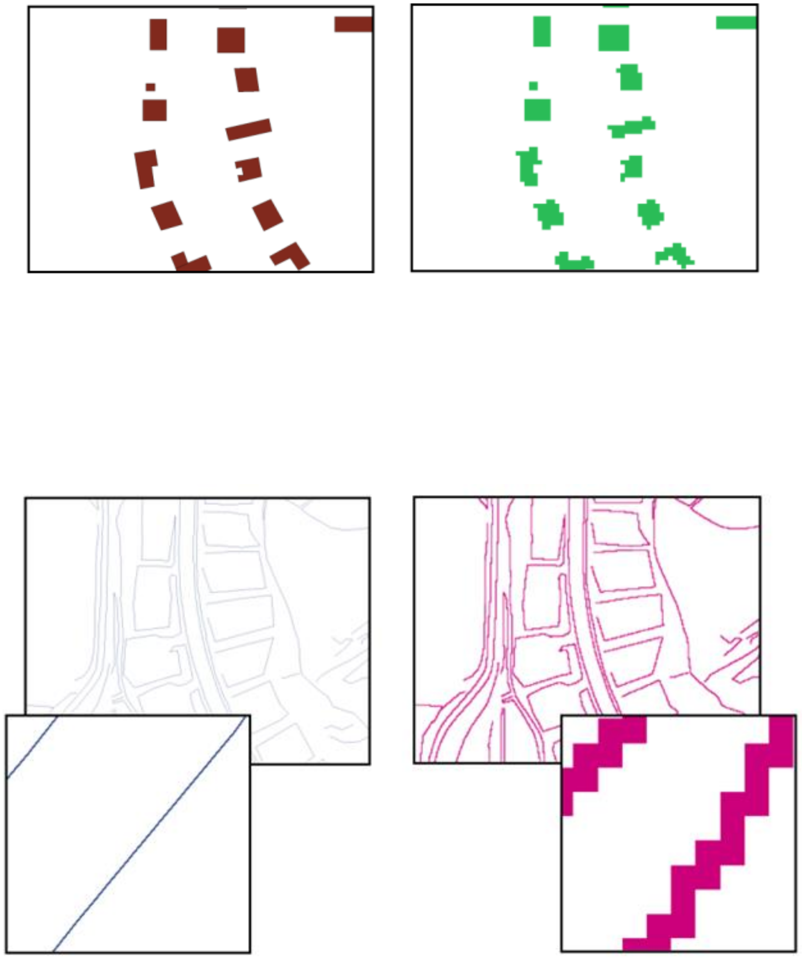
# REPRESENTATIONS OF GEOGRAPHIC FIELDS (DISCRETE)

- Discrete fields (like land-use or soil type) can be represented as:
  - Raster, &
  - Vector (Polygons)
- Discrete raster representations will lead to integer cell values

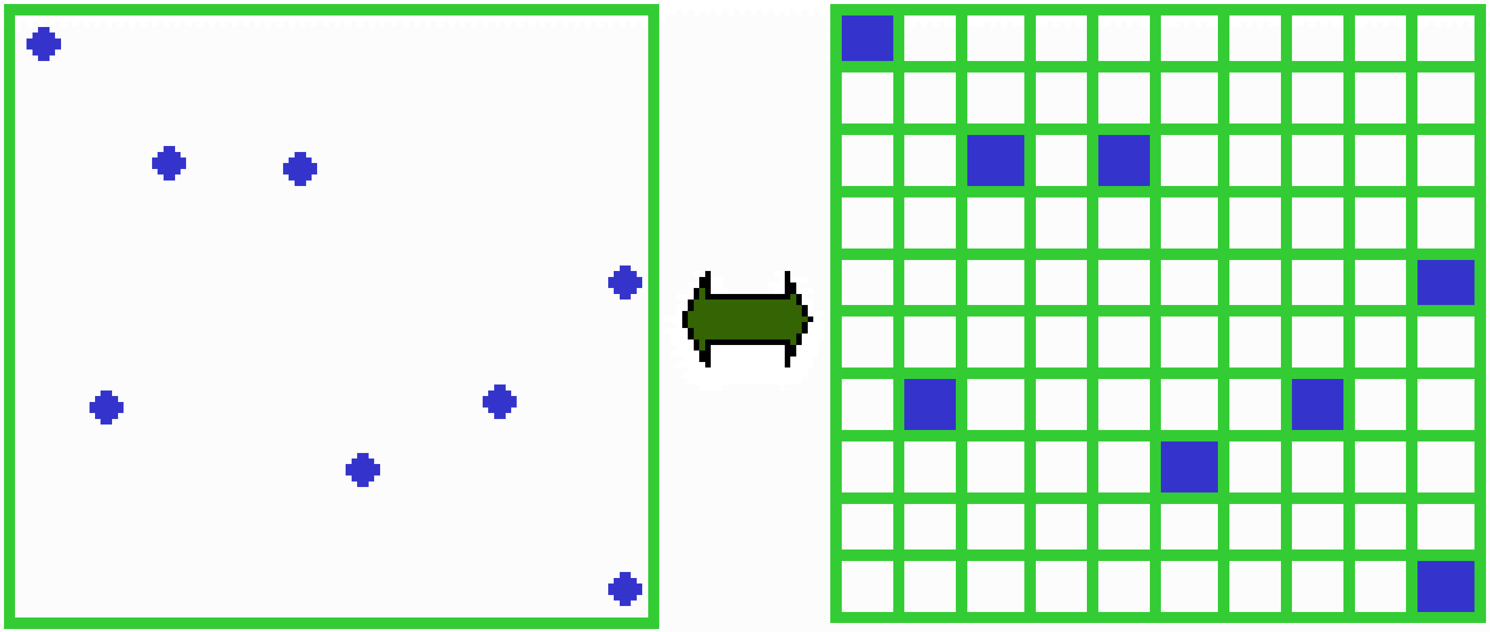


# Representation of Objects

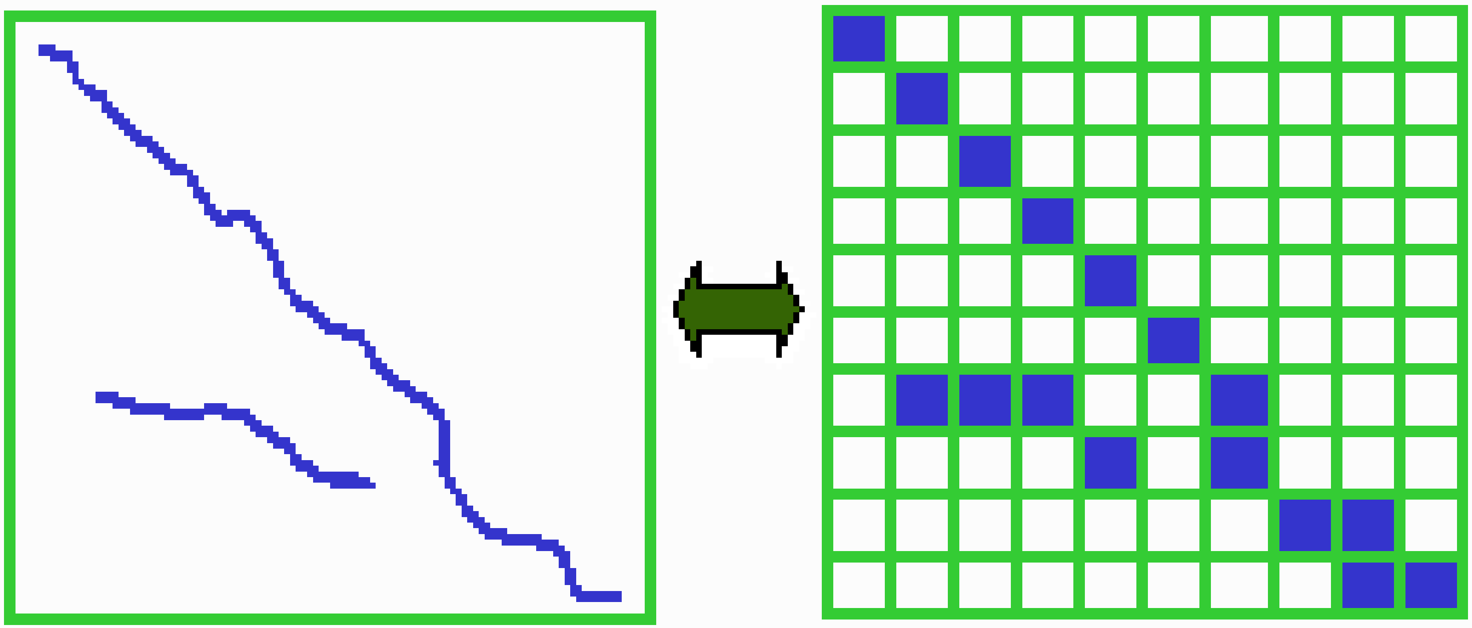
- Line and point objects are more awkward to represent using rasters, as rasters are area-based
- Objects are more naturally represented in vector



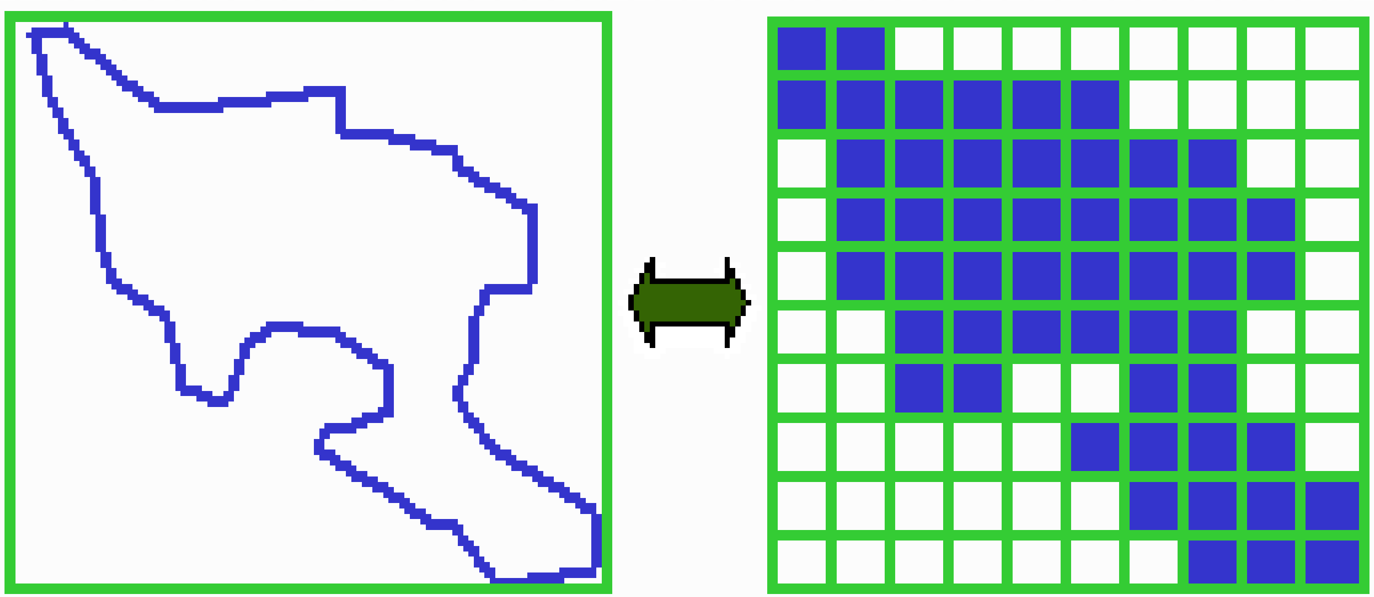
# Representation of Objects - Points as Cells



# Representation of Objects - Line as a Sequence of Cells



# Representation of Objects - Polygon as a Zone of Cells



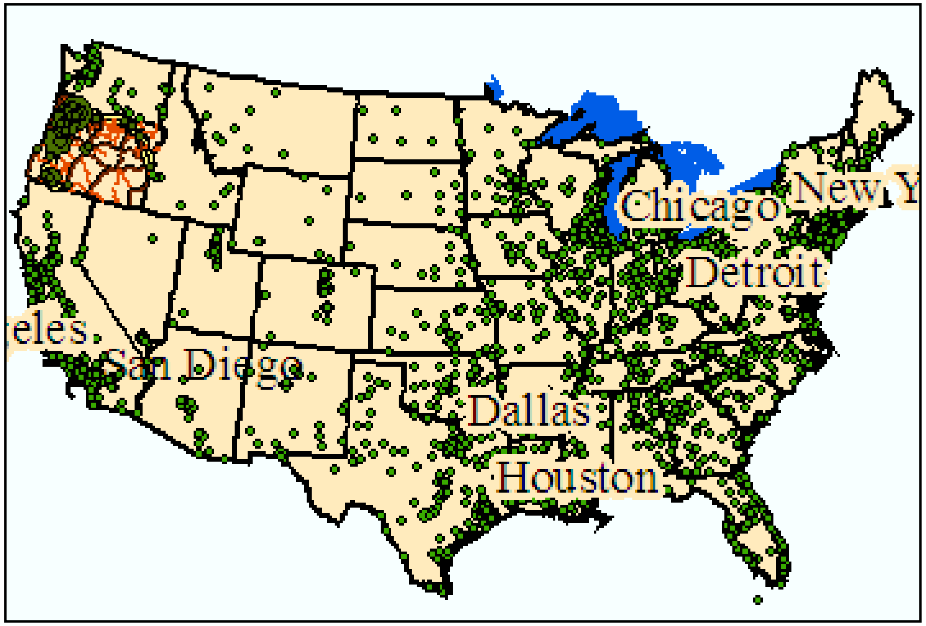
# Comparison

| Property | Raster Data Model | Vector Data Model |
|---|---|---|
| Data Structure | Simple | Complex |
| Overlaying | Easy and Efficient | Difficult to perform |
| Compatible to RS imagery | Yes | No |
| Spatial Variability | Efficient | Insufficient |
| Programmability | Simple | Difficult |
| Storage | Inefficient | Compact |
| Geometric Properties | Erroneous | Correct |
| Network Analysis | Difficult | Easy |
| Map Visual Appeal | Less | High |
| Information Variation | Based on resolution | Based on scale |
| Topology | Not implemented | Efficient encoding |

# Choice of representation

- From the suitable digital representations the choice is generally based on two issues:
  - What original raw data is available?
  - What sort of data manipulation does the application want to perform?

# Scale of a map - Example of representation of cities




- Small scale map
- 1:50million
- Preferably - Point

- Large scale map
- 1:5000
- Preferably - Polygon

Quiz time!

**Login through your mobile's browser**

**Also, send your queries through AView Question Box**

**Will be back in 10 mins!**

# https://tale.tn/7sW5Y1

# Quiz time!

## Fill a option in the correct box

| | Field (Continuous or Discrete) | Object (Point, Line or Polygon) |
|---|---|---|
| **Elevation Points** | | |
| **Canal (1:50,000)** | | |
| **River (1:5000)** | | |
| **Satellite Image (CartoSat - 1m)** | | |
| **Digital Elevation Model (DEM)** | | |
| **Satellite Image (LISS-3 - 24m)** | | |
| **Ward boundary** | | |

# Quiz time! - Answers

| | **Field (Continuous or Discrete)** | **Object (Point, Line or Polygon)** |
|---|---|---|
| **Elevation Points** | | ✓ Point |
| **Canal (1:50,000)** | | ✓ Line |
| **River (1:5000)** | | ✓ Polygon |
| **Satellite Image (CartoSat - 1m)** | ✓ Continuous | |
| **Digital Elevation Model (DEM)** | ✓ Continuous | |
| **Satellite Image (LISS-3 - 24m)** | ✓ Continuous | |
| **Ward boundary** | | ✓ Polygon |


# Thank You

Contact Details:

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