

Introduction to Spatial Data

HES 505 Fall 2023: Session 3

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Today's Plan

1. Ways to view the world
2. What makes data (geo)spatial?
3. Coordinate Reference Systems
4. Geometries, support, and spatial messiness

How do you view the world?

...As a Series of Objects?

- The world is a series of *entities* located in space.
- Usually distinguishable, discrete, and bounded
- Some spaces can hold multiple entities, others are empty
- Objects are digital representations of entities



...As a Continuous Field

How did the data arise?

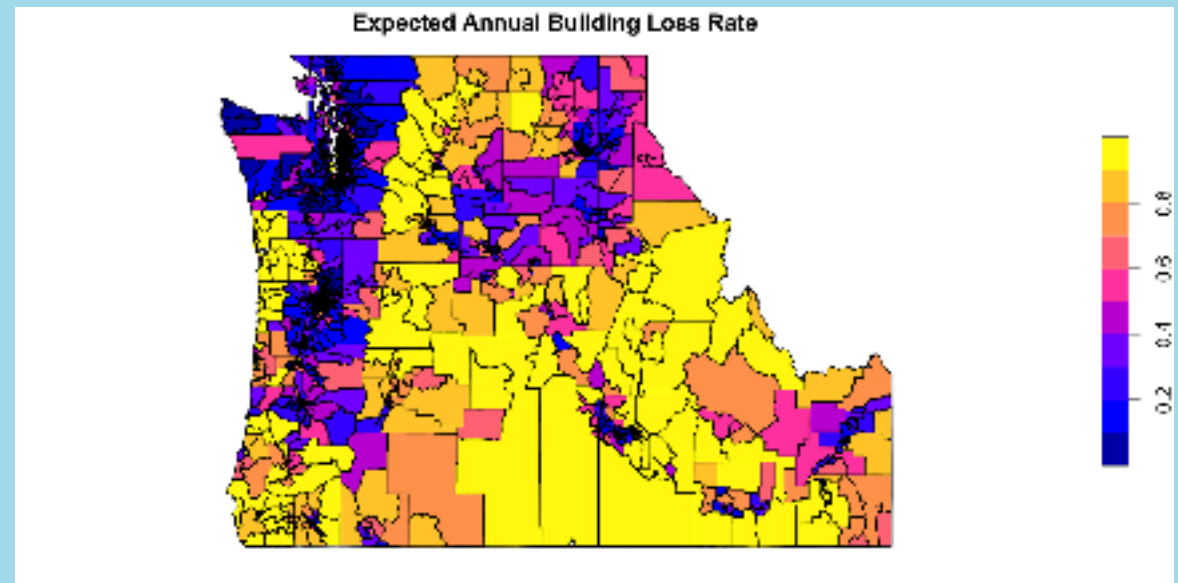
Spatial data as a stochastic process

$$Z(\mathbf{s}) : \mathbf{s} \in D \subset \mathbb{R}^d$$

Areal Data

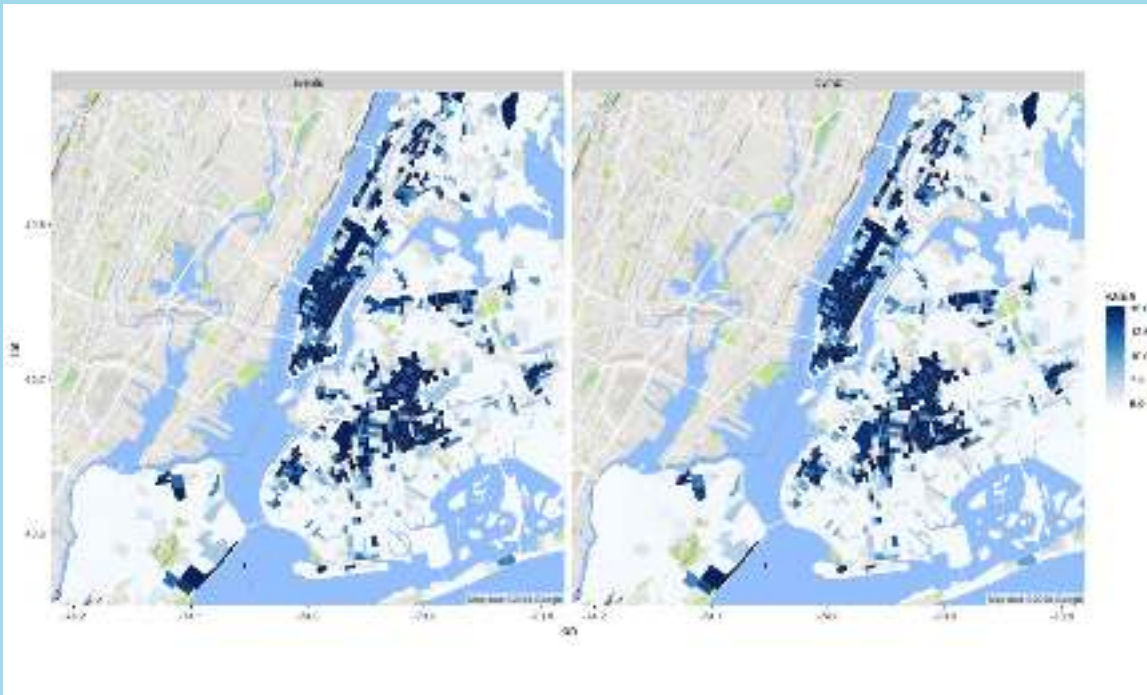
$$Z(s) : s \in D \subset \mathbb{R}^d$$

- D is fixed domain of countable units
- Typically involve some aggregation



Geostatistical data

$$Z(s) : s \in D \subset \mathbb{R}^d$$

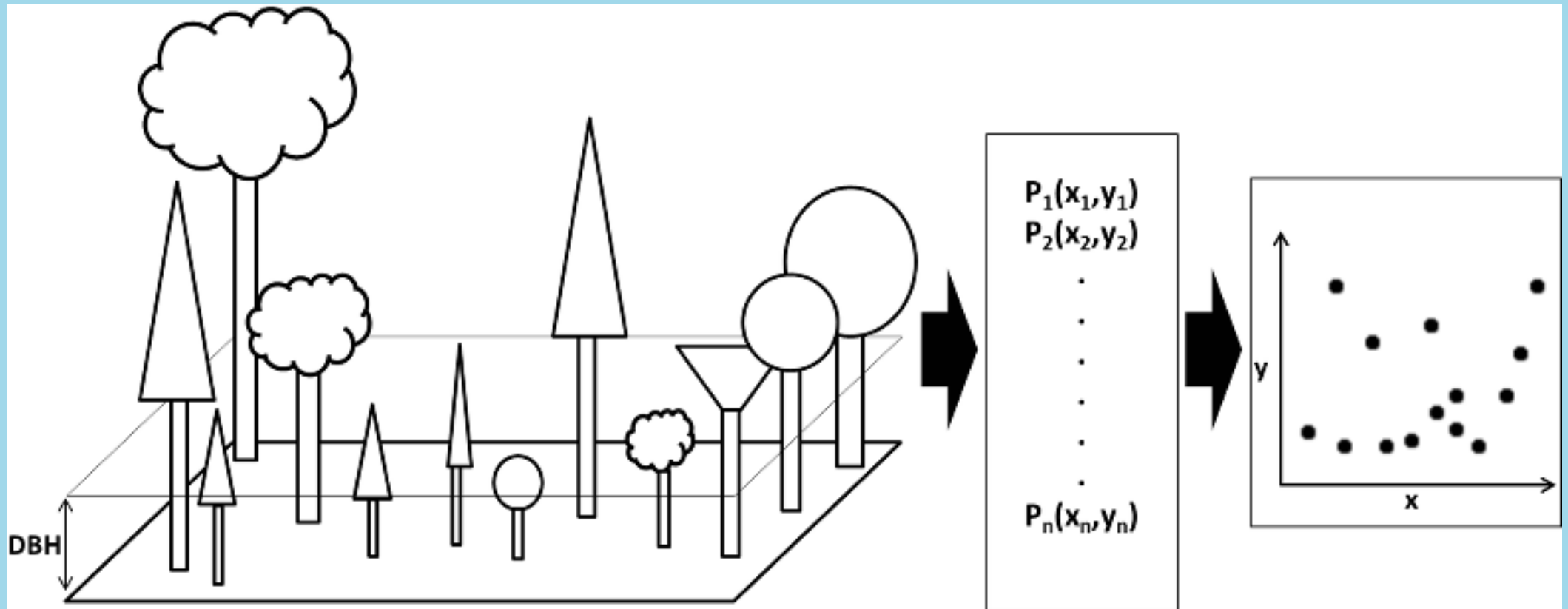


- D is a fixed subset of \mathbb{R}^d
- $Z(s)$ could be observed at any location within D .
- Models predict unobserved locations

Point patterns

$$Z(s) : s \in D \subset \mathbb{R}^d$$

- D is random; where s depicts the location of events



How is the data stored?

What is a data model?

- **Data:** a collection of discrete values that describe phenomena
- Your brain stores millions of pieces of data
- Computers are not your brain
 - Need to organize data systematically
 - Be able to display and access efficiently
 - Need to be able to store and access repeatedly
- Data models solve this problem

2 Types of Spatial Data Models

- **Raster:** grid-cell tessellation of an area. Each raster describes the value of a single phenomenon. More next week...
- **Vector:** (many) attributes associated with locations defined by coordinates

The Vector Data Model

- **Vertices** (i.e., discrete x-y locations) define the shape of the vector
- The organization of those vertices define the *shape* of the vector
- General types: points, lines, polygons

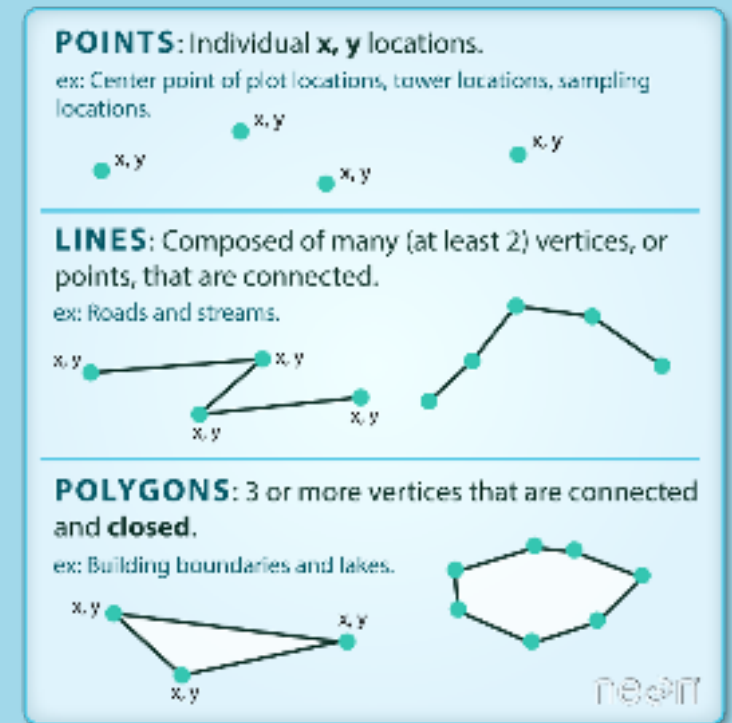
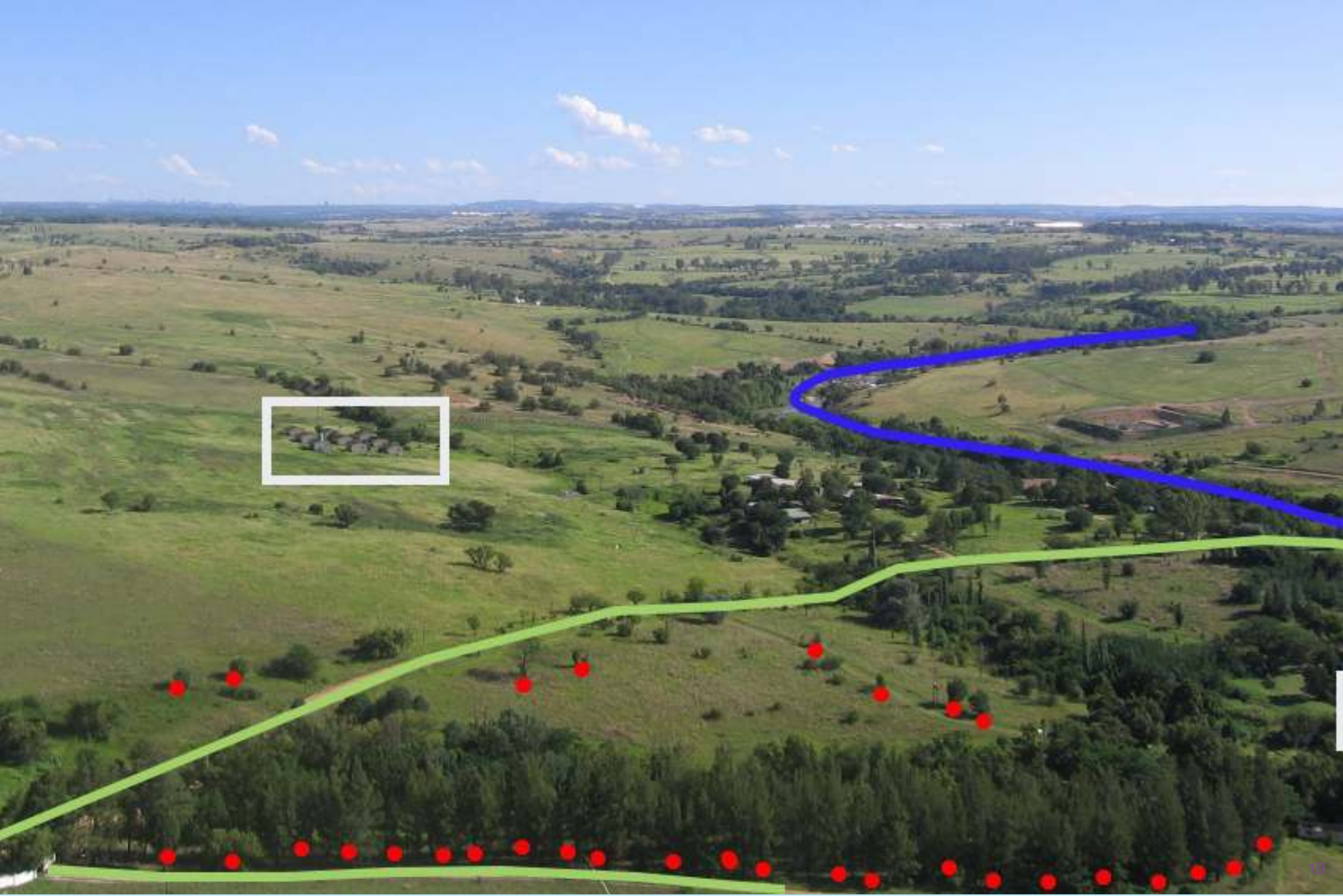
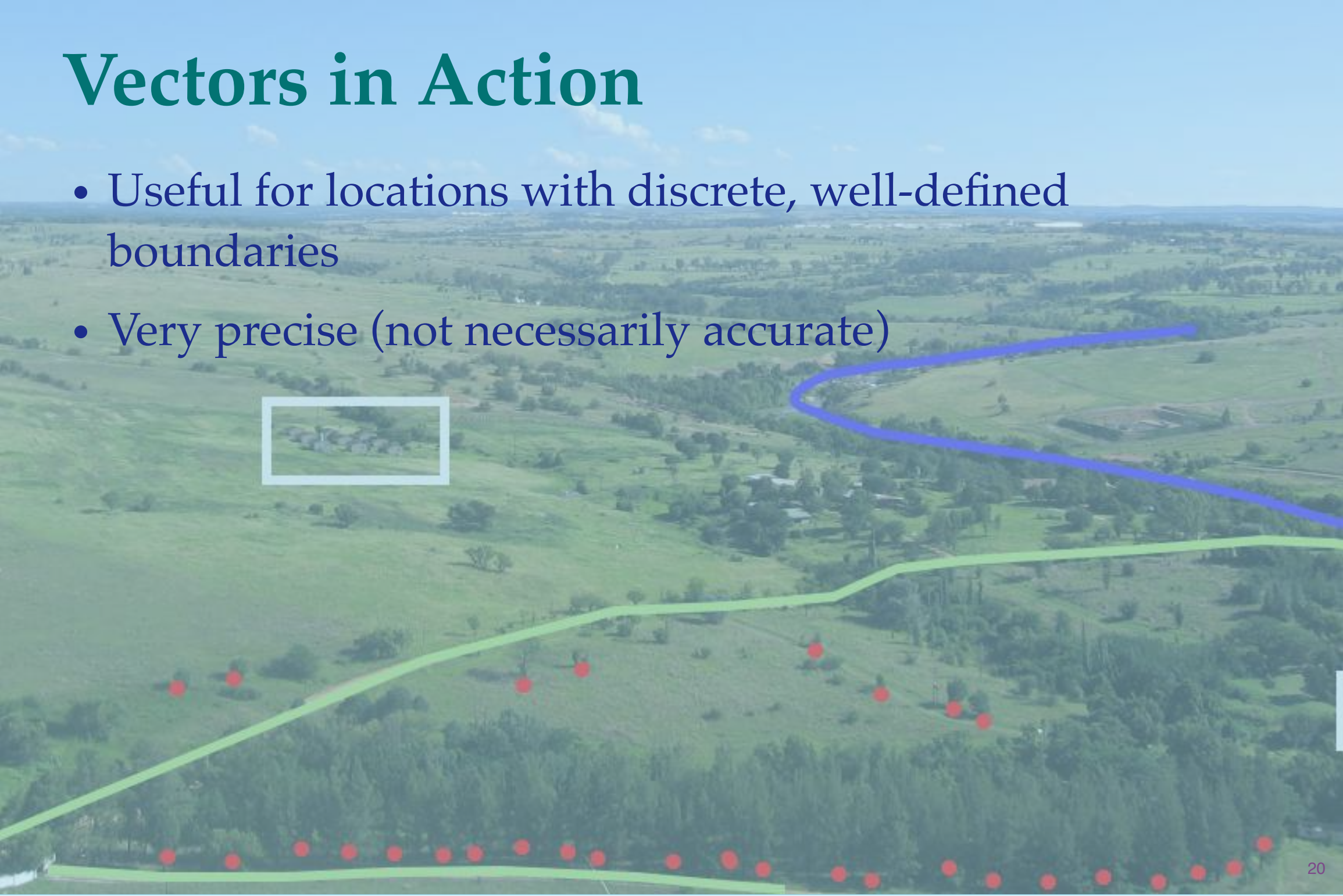


Image Source: Colin Williams
(NEON)



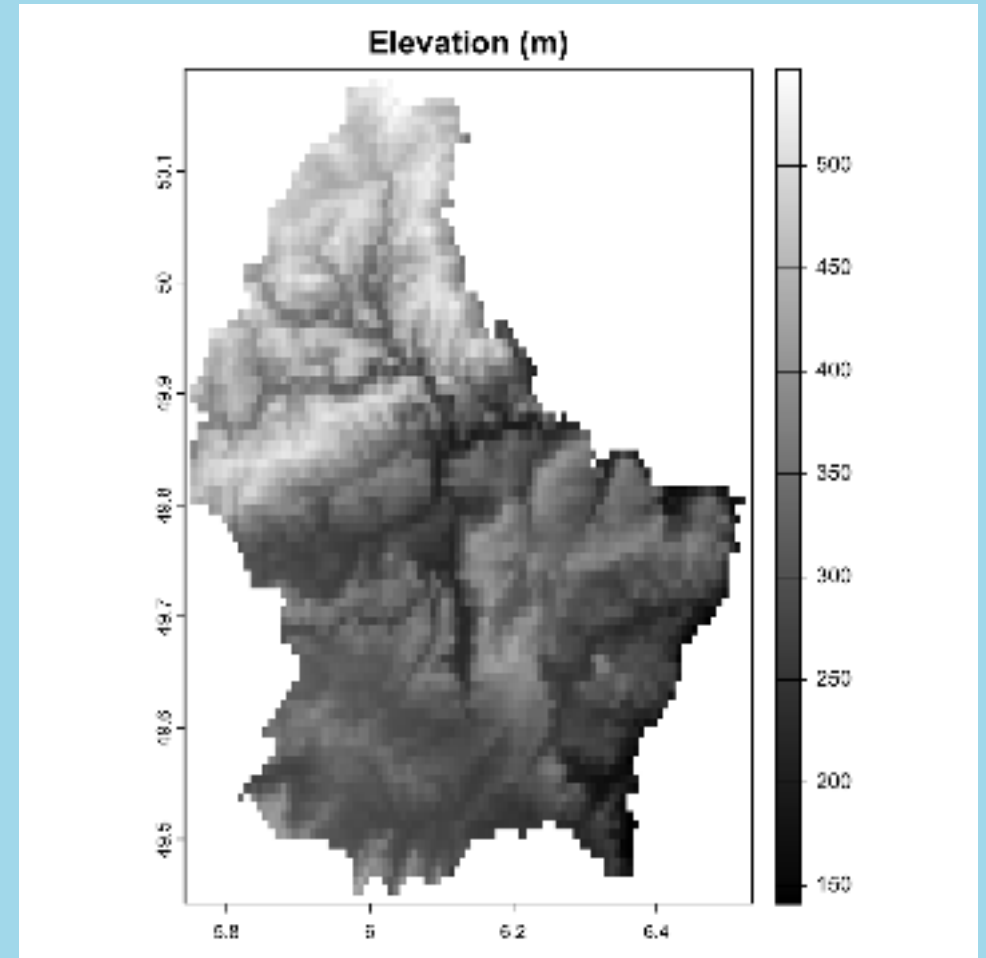
Vectors in Action

- Useful for locations with discrete, well-defined boundaries
- Very precise (not necessarily accurate)

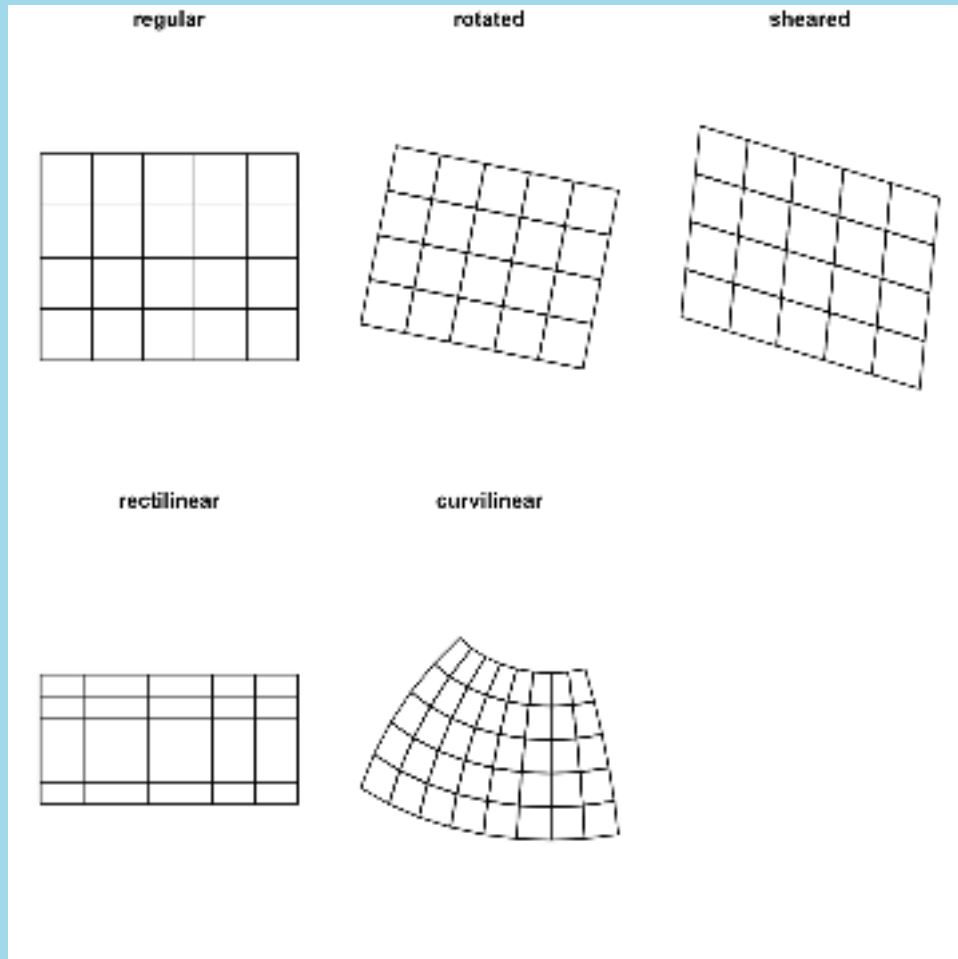


The Raster Data Model

- Raster data represent spatially continuous phenomena (NA is possible)
- Depict the alignment of data on a regular lattice (often a square)
- Geometry is implicit; the spatial extent and number of rows and columns define the cell size



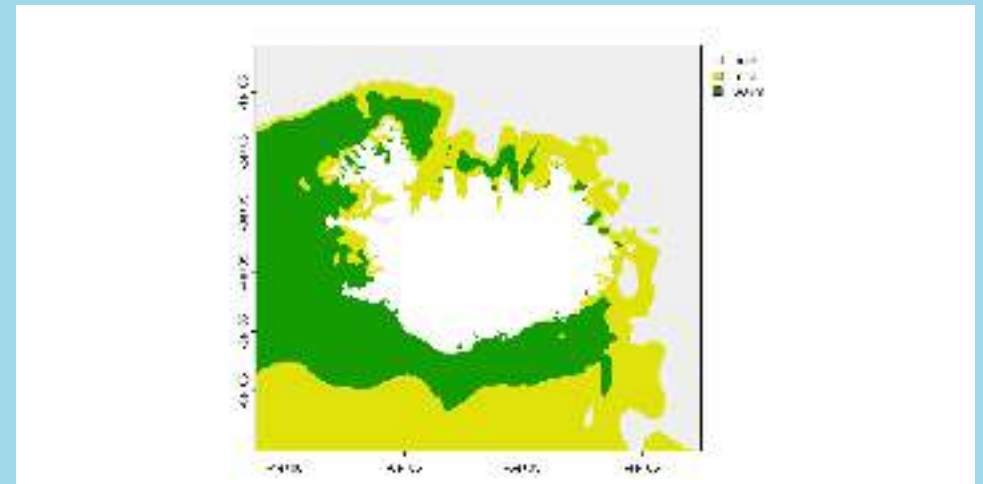
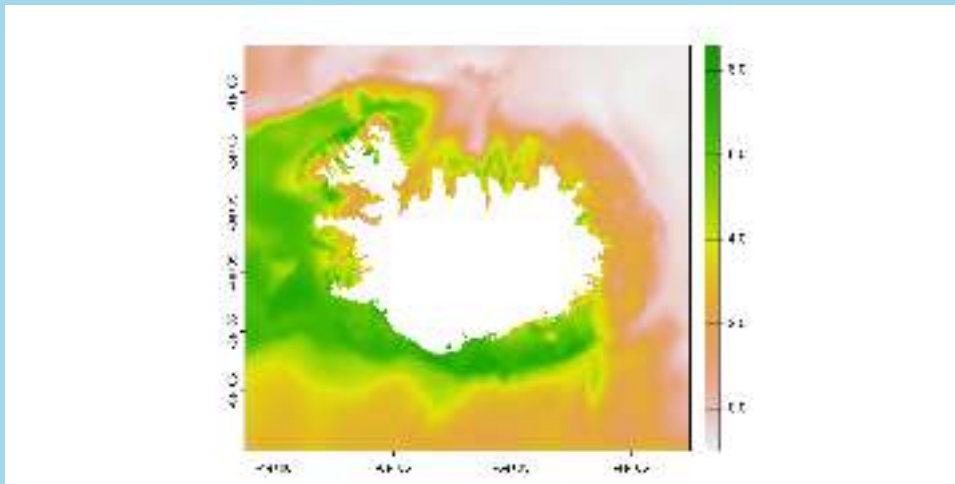
Types of Raster Data



- **Regular**: constant cell size; axes aligned with Easting and Northing
- **Rotated**: constant cell size; axes not aligned with Easting and Northing
- **Sheared**: constant cell size; axes not parallel
- **Rectilinear**: cell size varies along a dimension
- **Curvilinear**: cell size and orientation dependent on the other dimension

Types of Raster Data

- **Continuous:** numeric data representing a measurement (e.g., elevation, precipitation)
- **Categorical:** integer data representing factors (e.g., land use, land cover)



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