



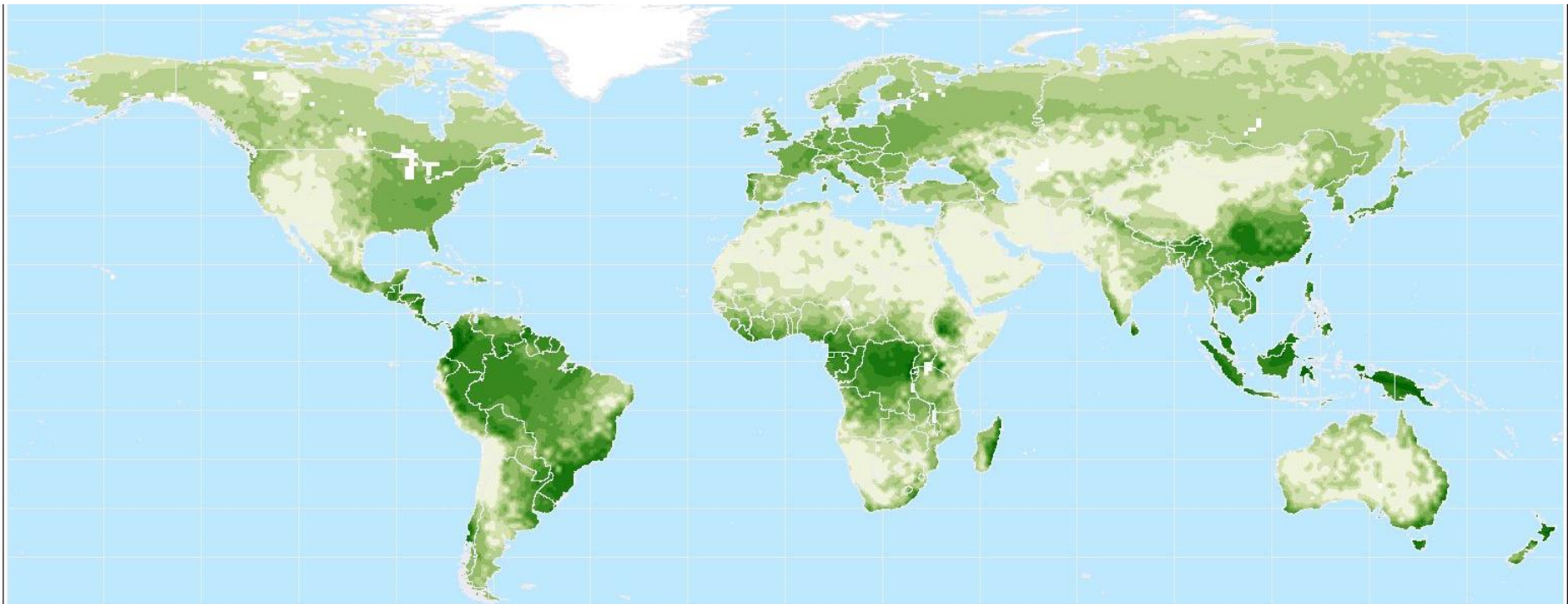
INVESTMENTS IN EDUCATION DEVELOPMENT

# Mapping and modeling species distributions

Department of Botany and Zoology, Masaryk University

Bi9661 Selected issues in Ecology, Autumn 2013

Borja Jiménez-Alfaro, PhD



Part 1:

MAPPING

**SCALE, EXTENT, GRAIN AND ACCURACY**

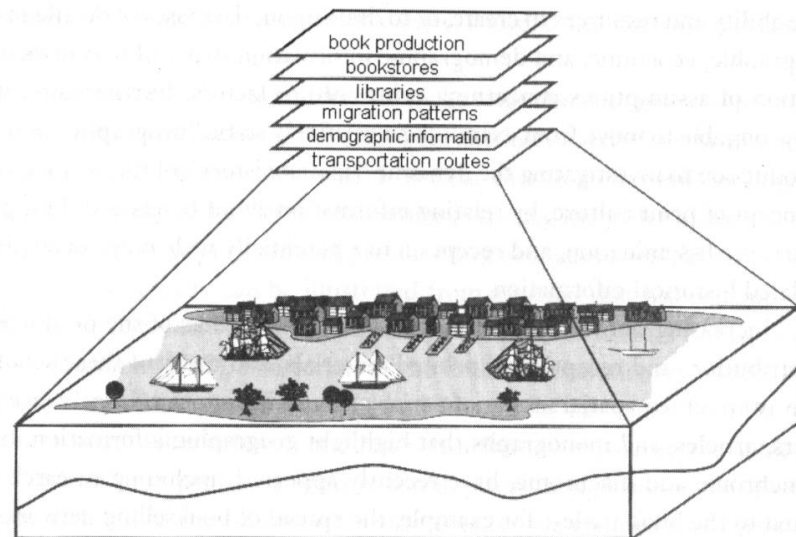
## Objectives of this practice

- 1)  
Understand the format of observational data (Occurrences)  
Import the occurrences into Diva-GIS and create a SHAPEFILE  
First contact with GIS???
  
- 2)  
Understand the format of GIS environmental variables  
Assess the fit between occurrences and GIS layers
  
- 3)  
**INSTALLATION OF DIVA-GIS and MAXENT**  
**PREPARATION of INPUT FILES**

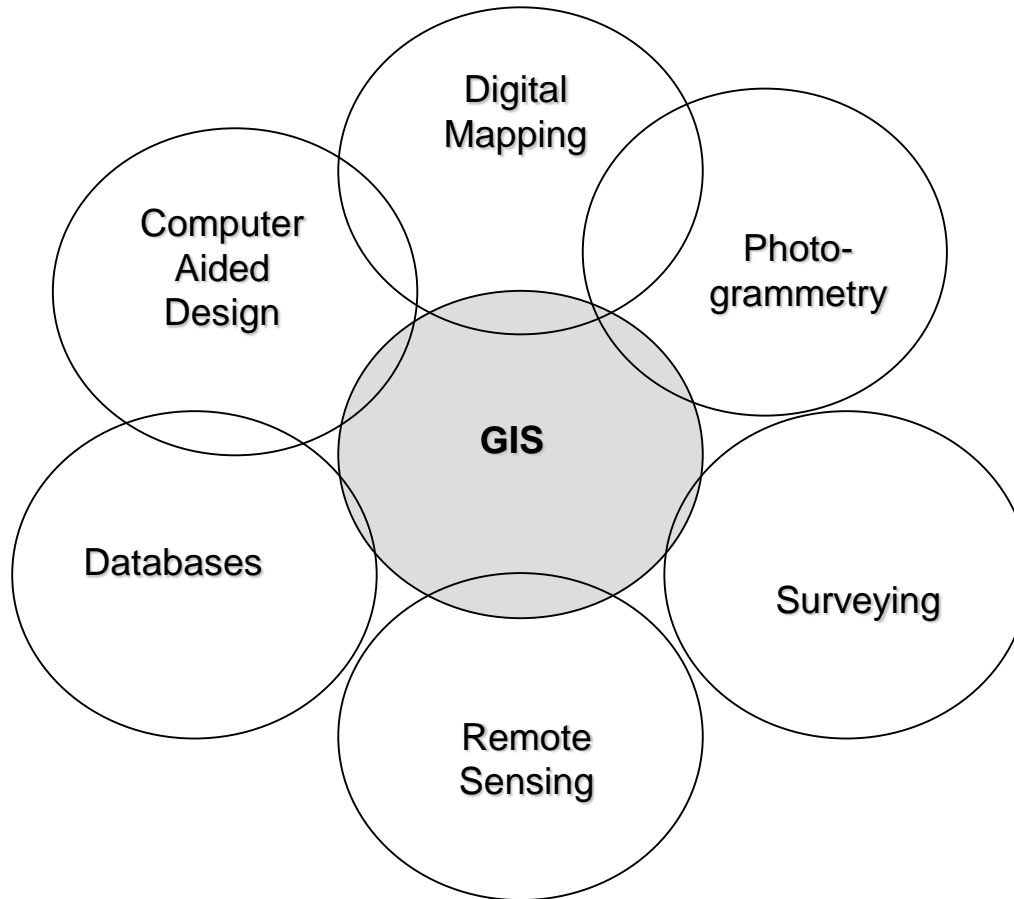
# What is a GIS?

## Geographic Information System

“A system for capturing, storing, checking, integrating, manipulating, analysing and displaying data which are spatially referenced to the Earth. This is normally considered to involve a spatially referenced computer database and appropriate applications software”



# What is a GIS?



Cross-disciplinary nature of GIS

## Two main types of data

### Attribute data (the INFORMATION)

Says what a feature is

Eg. statistics, text, images, sound, etc.

### Spatial data (the GEOGRAPHY)

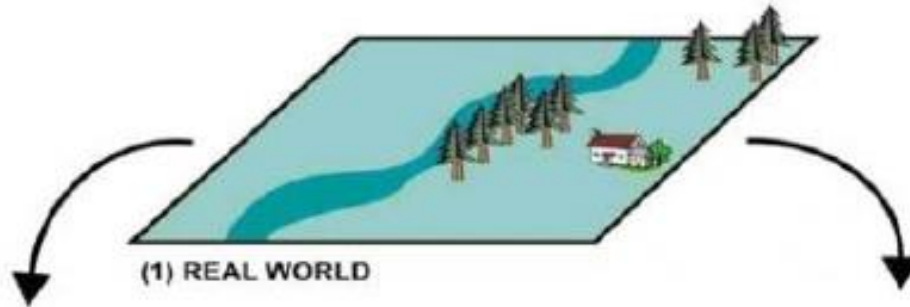
Says where the feature is

Co-ordinate based

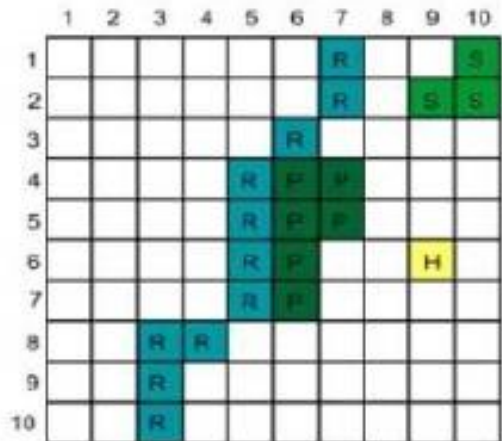
**Vector data** – discrete features (points, lines, polygons)

**Raster data** – A continuous surface

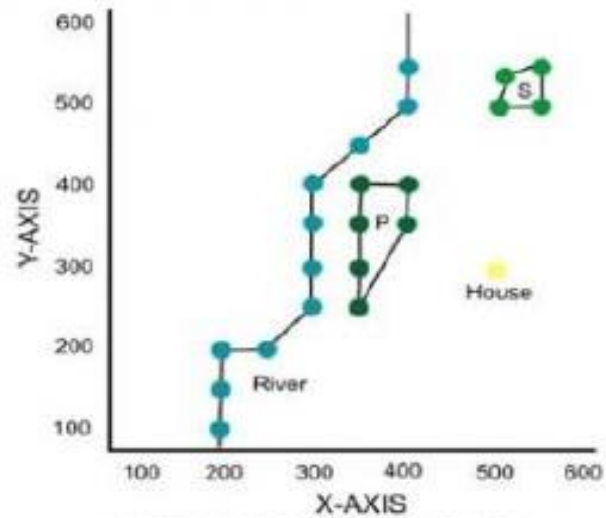
# Layers: RASTER vs. VECTORIAL



cookbook.hlurb.gov.ph

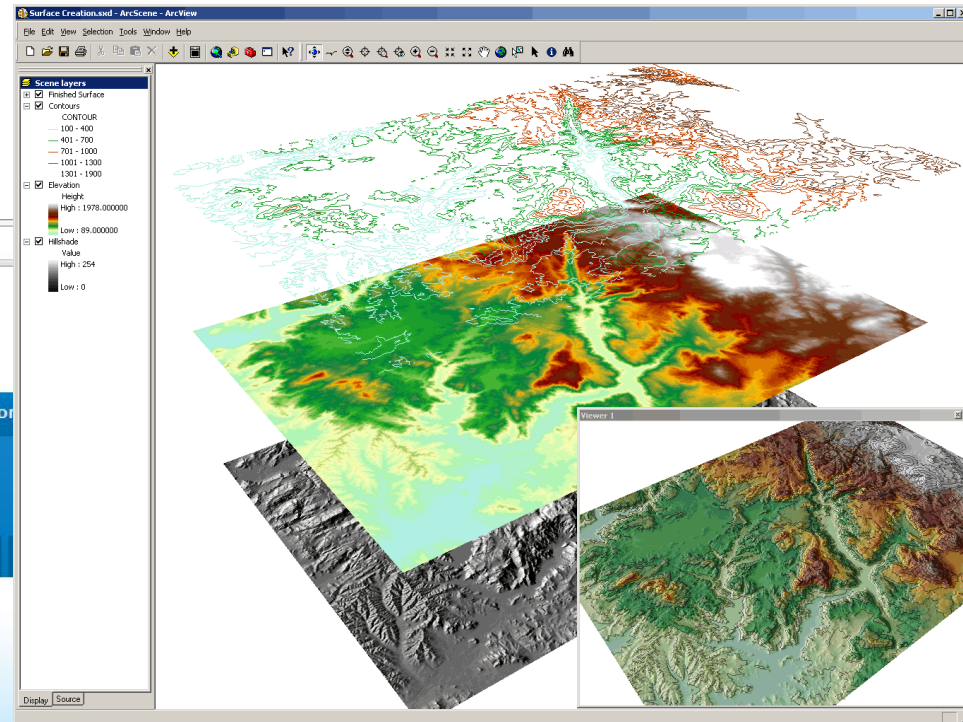
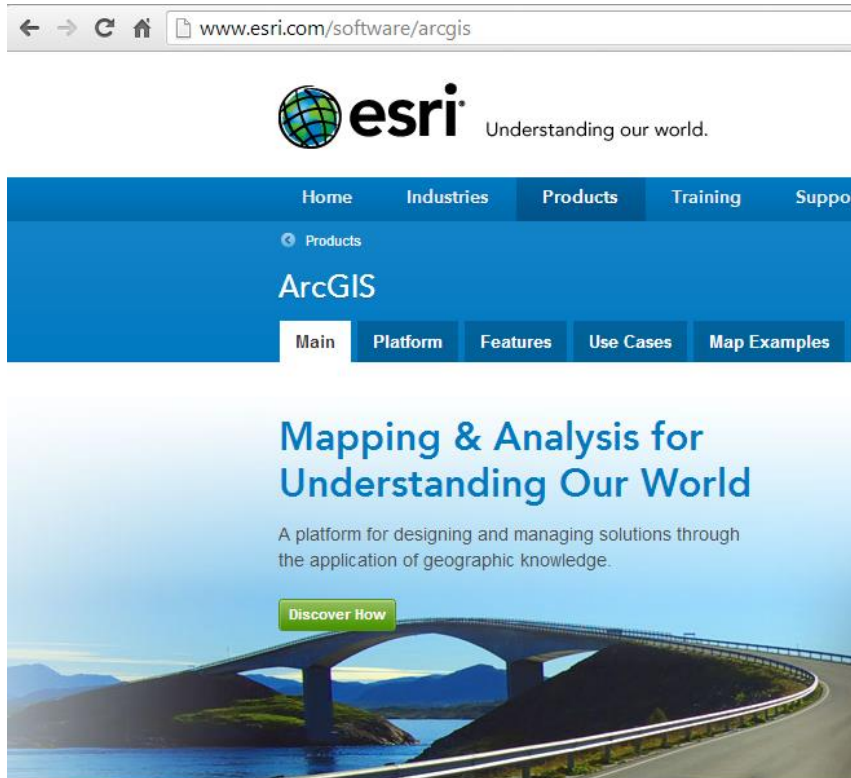


(2) RASTER REPRESENTATION



(3) VECTOR REPRESENTATION

# Software – ArcGIS



ArcGIS includes solutions and tools for:

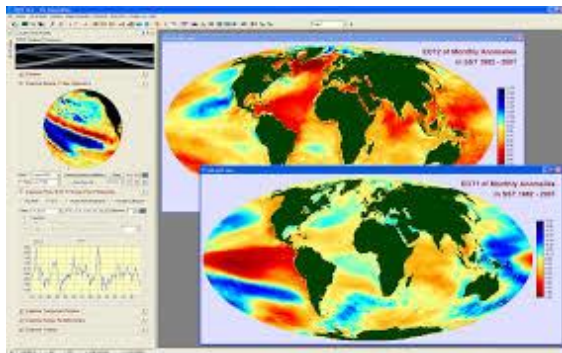
GIS Professionals

Location Analytics

Developers



# Software - IDRISI

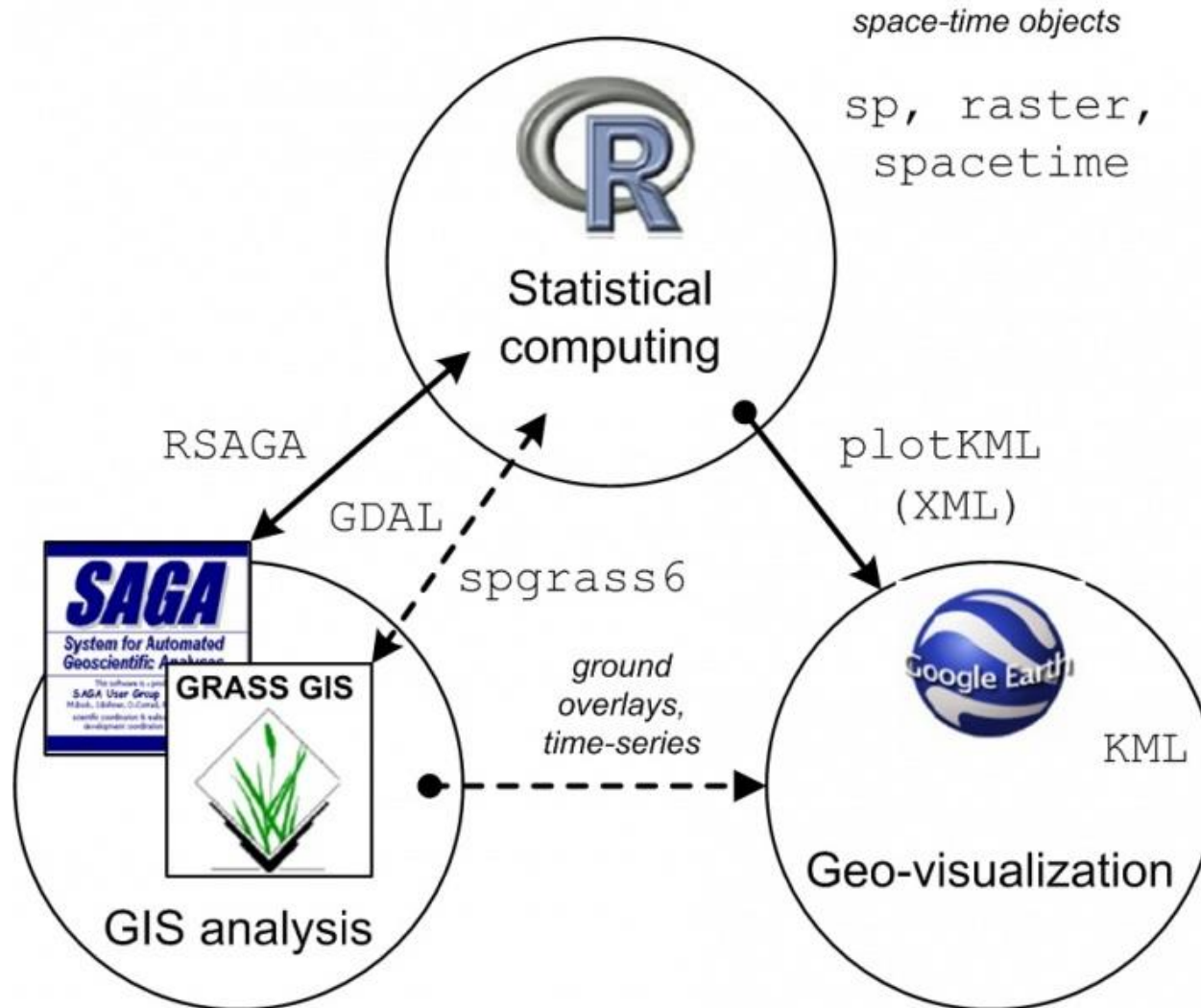


A screenshot of the Clark Labs website homepage. The browser address bar shows 'clarklabs.org'. The website header includes the 'CLARK LABS' logo and navigation links: HOME, CONTACT US, HOW TO BUY, SITE MAP, and SEARCH. A secondary navigation bar contains APPLICATIONS, PRODUCTS, HOW TO BUY, SUPPORT, RESOURCES, and ABOUT CLARK LABS. The main heading reads 'Geospatial software for monitoring and modeling the Earth system'. Below this is a large image of a 3D terrain model with a green and purple overlay, titled 'Land Cover Mapping and Modeling' with the subtitle 'Maximize satellite imagery for geospatial analysis'. A row of six small square icons is positioned below the image. On the left, a 'Quick Links' section lists: Product Features, What's New in IDRISI Selva, IDRISI Brochure, Teach with IDRISI, and Consulting Services. To the right of this list, another set of links includes: Advanced Image Processing, Land Change Analysis, REDD Project Modeling, Object-Oriented Segmentation, and Earth Trends Modeler. On the far right, there are two buttons: 'ORDER NOW!' and 'REQUEST A TRIAL'. Below these buttons is the 'IDRISI Selva Features' section, which includes a small screenshot of the software interface showing three maps of a region.

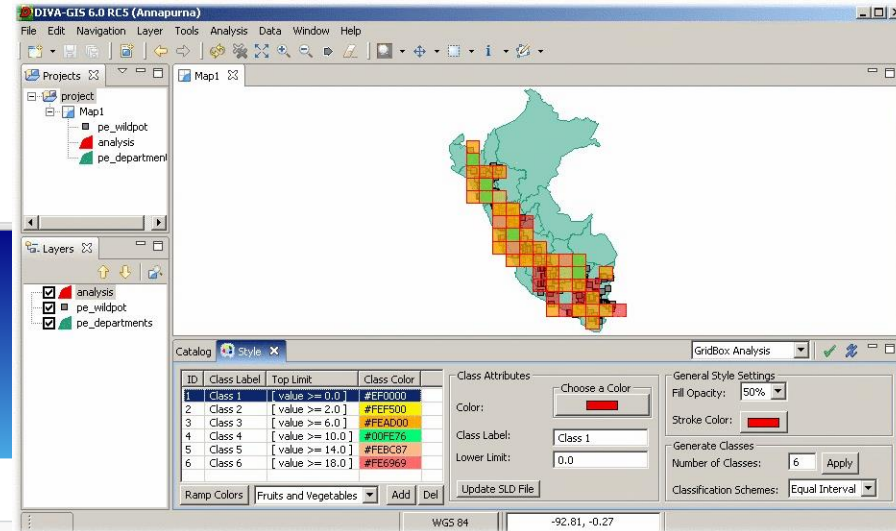
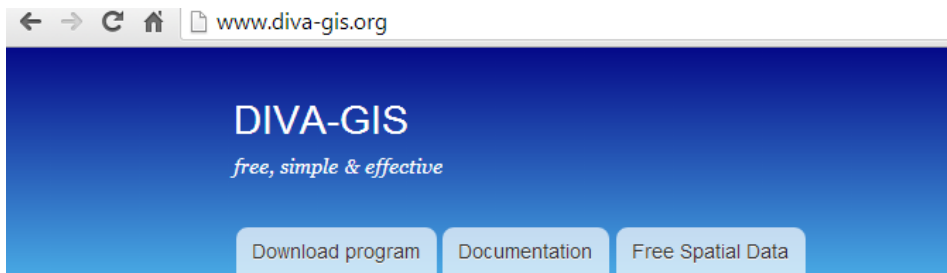
# Software – GRASS GIS (Free)

The screenshot shows the GRASS GIS website homepage. The browser address bar displays 'grass.osgeo.org'. The main header features the GRASS GIS logo and the text 'The world's leading Free GIS software'. A navigation menu includes links for Home, Download, Documentation, Gallery, Support, Donations, Development, and Get involved!. On the left side, there is a search bar and a 'Latest News' section with two entries: 'Stable GRASS GIS 6.4.3 released' and '30 years of GRASS GIS development Celebrating 30 years of GRASS GIS!'. Below the news is a 'User map' section with an interactive map of Europe. The main content area is titled 'Home' and features a 'Celebrating 30 years!' banner with a 30th anniversary logo. The banner text describes GRASS GIS as a free and open source GIS software suite used for geospatial data management and analysis. Below the banner are three operating system icons: Mac OSX, Windows, and Linux. A 'Newcomers: How to start with GRASS?' section lists links for 'About GRASS GIS', 'First Day Documentation', 'Tutorial and Courses', and 'GRASS GIS migration hints'. To the right, a 'Screenshots (click for more)' section shows a preview of the GRASS GIS desktop interface. At the bottom right, there is a download button labeled 'Mostrar todas las descargas...'. A file download bar at the bottom left shows 'images.jpg'.

# 100% Free



# Software – DIVA-GIS (free)



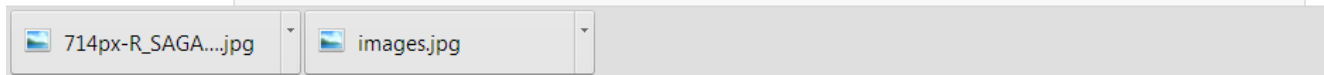
## DIVA-GIS

DIVA-GIS is a free computer program for mapping and geographic data analysis (a geographic information system (GIS)). With DIVA-GIS you can make maps of the world, or of a very small area, using, for example, state boundaries, rivers, a satellite image, and the locations of sites where an animal species was observed. We also provide [free spatial data](#) for the whole world that you can use in DIVA-GIS or other programs.

You can use the [discussion forum](#) to ask questions, report problems, or make suggestions. Or [contact us](#), and read the [blog entries](#) for the latest news. But first [download](#) the program and read the [documentation](#).

DIVA-GIS is particularly useful for mapping and analyzing biodiversity data, such as the distribution of species, or other 'point-distributions'. It reads and write standard data formats such as ESRI shapefiles, so interoperability is not a problem. DIVA-GIS runs on Windows and (with minor effort) on Mac OSX ([see instructions](#)).

You can use the program to analyze data, for example by making grid (raster) maps of the distribution of biological diversity, to find areas that have high, low, or complementary levels of diversity. And you can also map and query climate data. You can predict species distributions using the BIOCLIM or DOMAIN models.



## Basic concepts

### Scale and extent

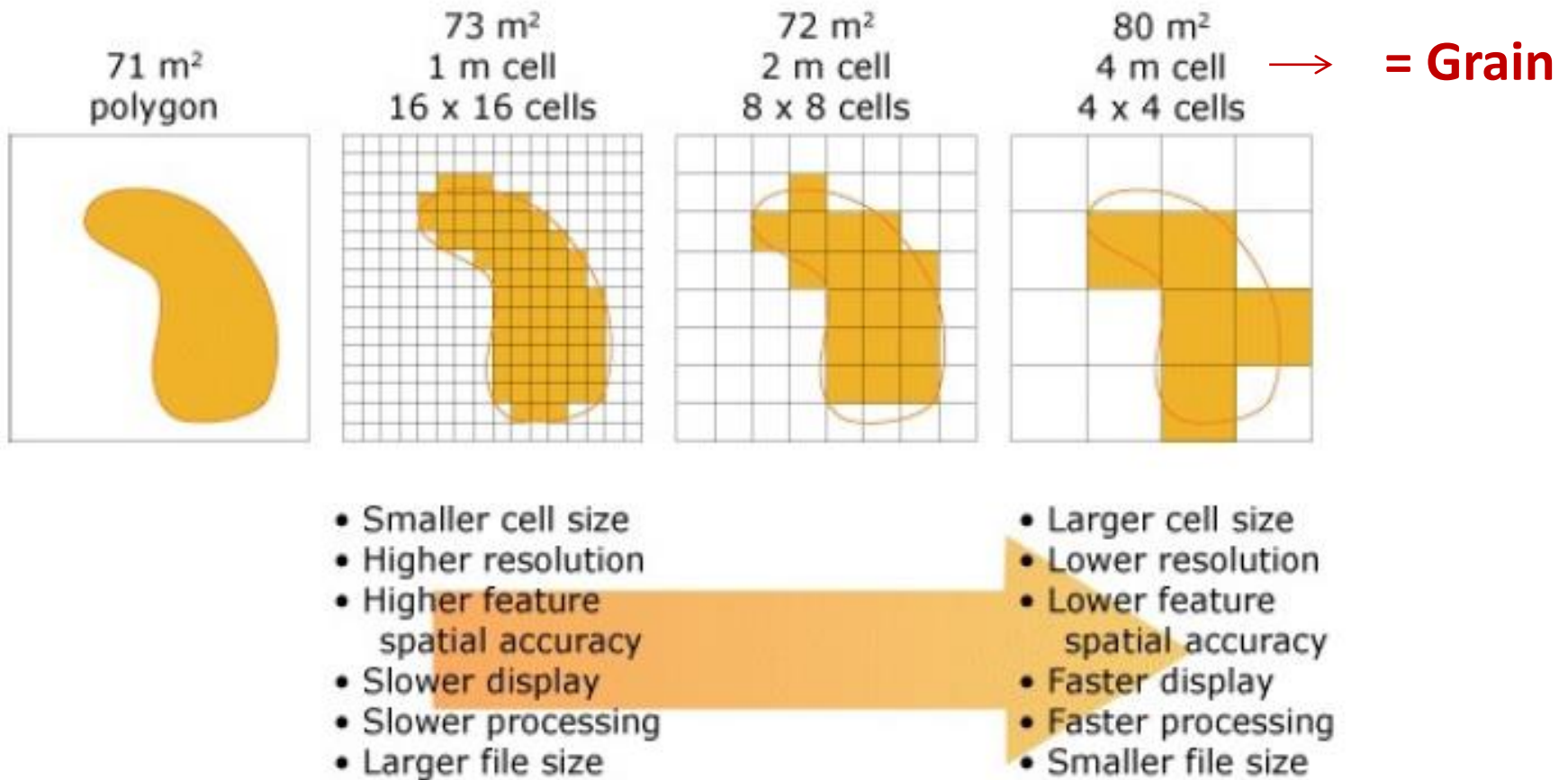
In spatial ecology, **scale** refers to the spatial **extent** of ecological processes and the spatial interpretation:

LOCAL, REGIONAL, GLOBAL

In the GIS world, **scale** is the relationship of the distance on the map/data to the actual distance on the ground, and **extent** refers to the dimension of the layers

## Basic concepts

### Resolution



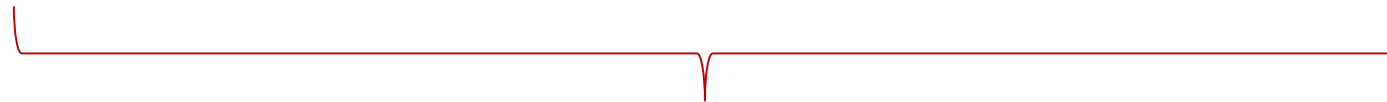
## Basic concepts

### Precision

refers how exact is the description of data

### Accurary

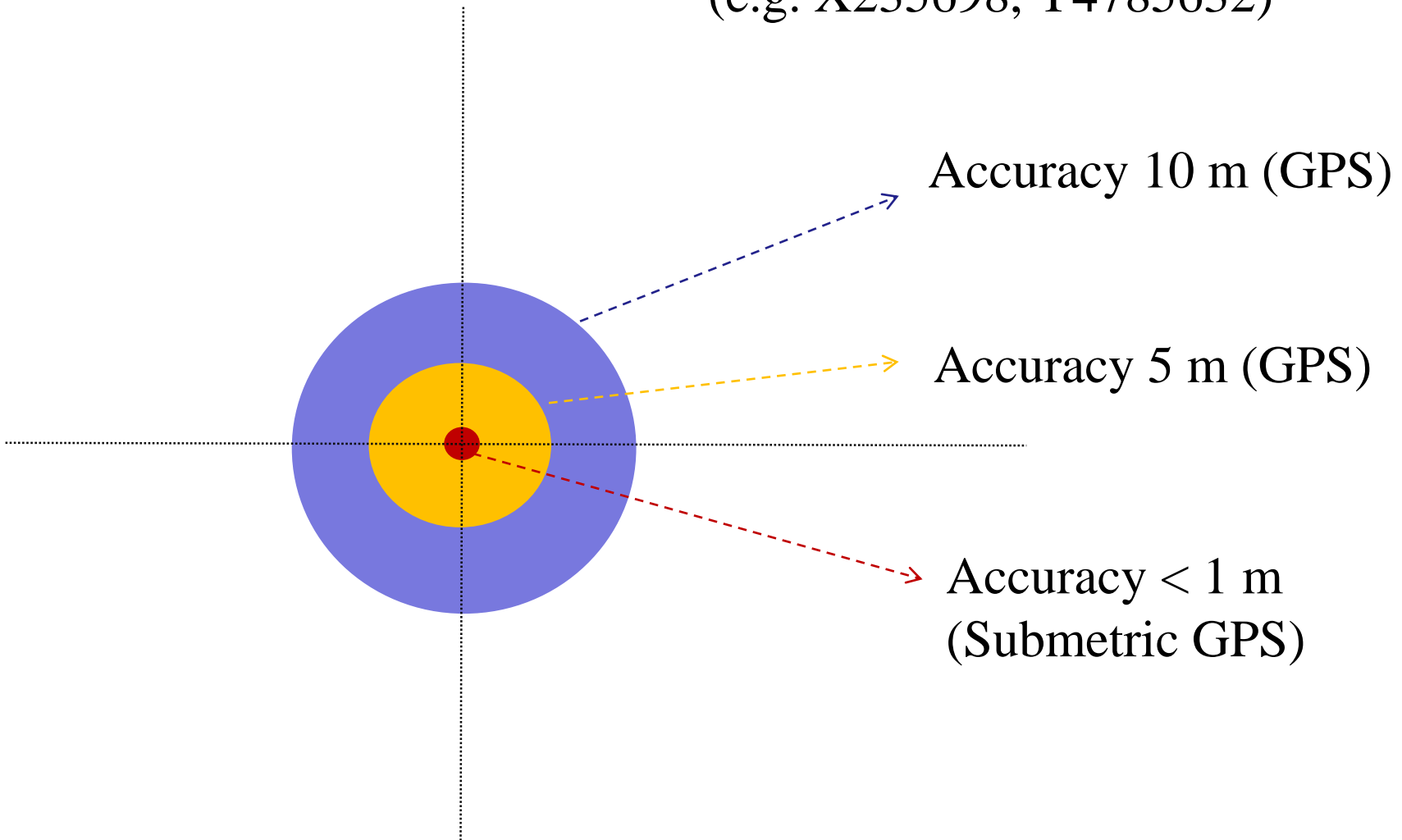
the degree or closeness to which the information on a map matches the real world



Important issues for spatial analyses

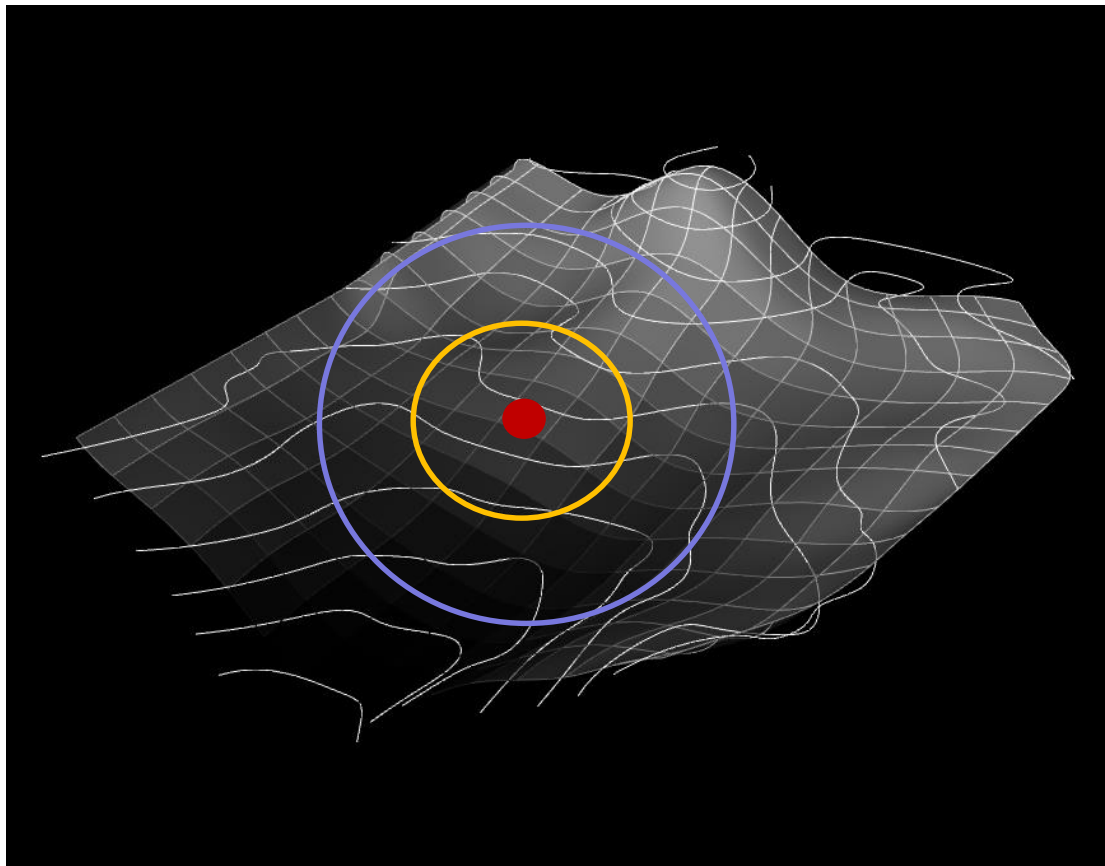
e.g. to test the fit between your **occurrences** and the **variables**

Imagine one location and its coordinates at precision = 1 m  
(e.g. X235698, Y4785632)





## Topographic gradient: **accuracy matters;**

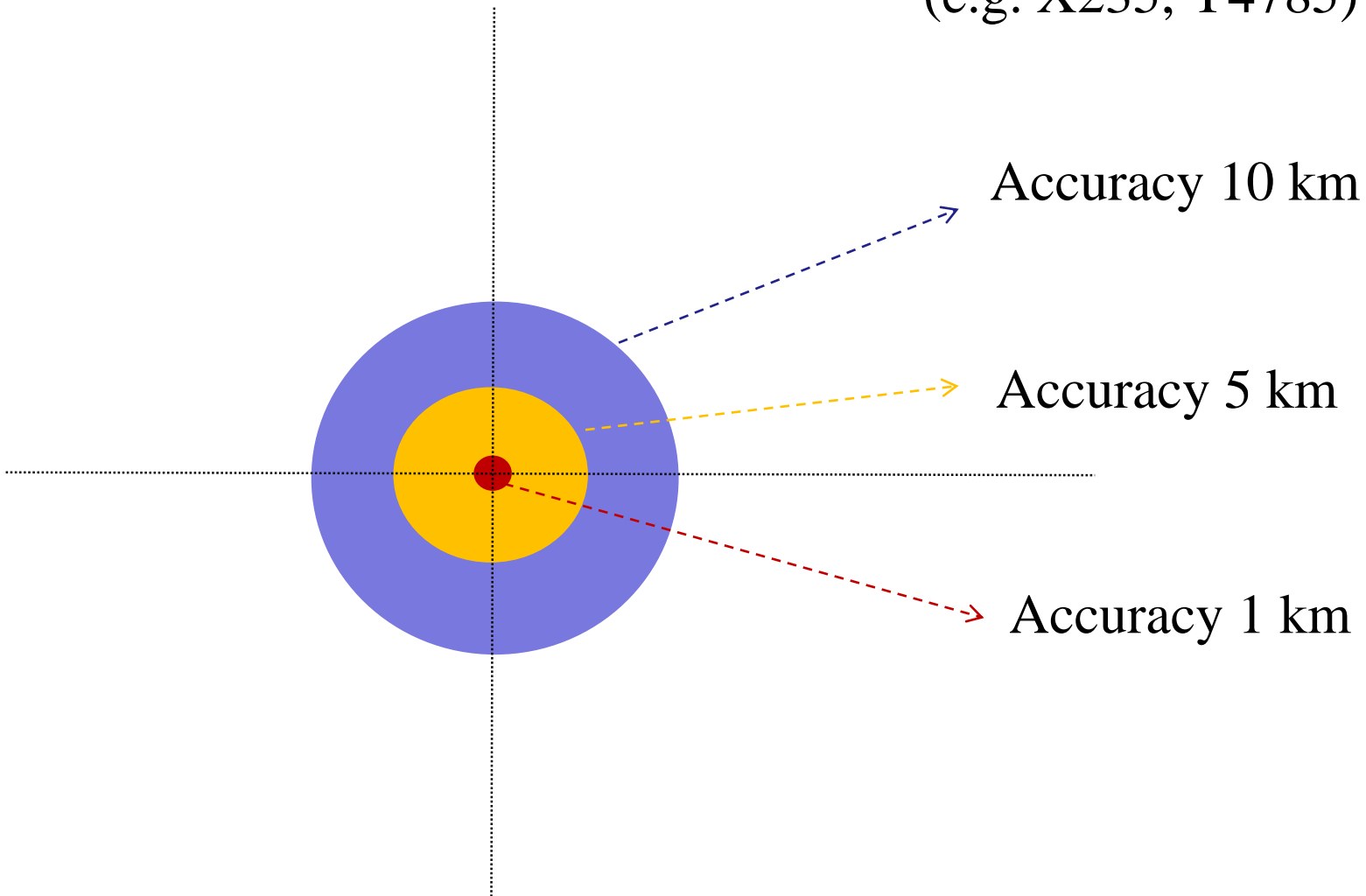


5 m

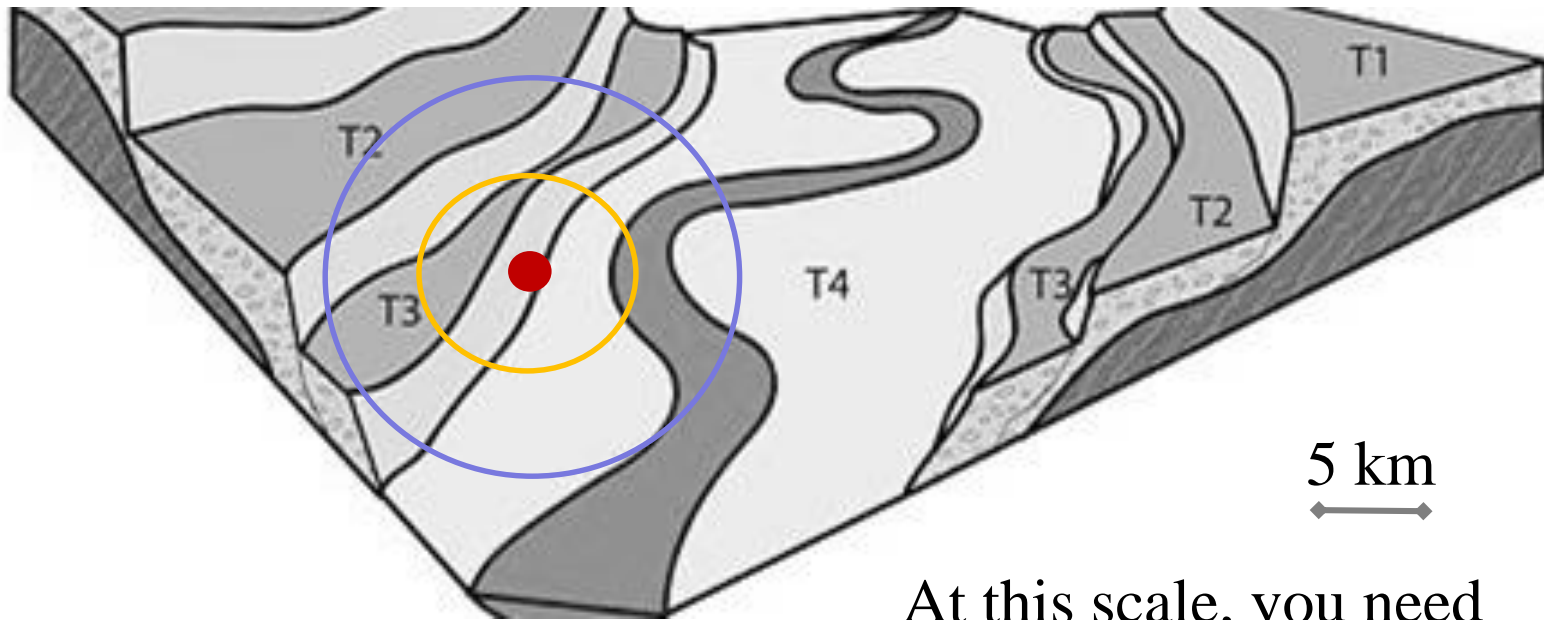


At this scale, you need  
precision and accuracy  
of  $< 5$  m

Imagine one location and its coordinates at precision = 1 km  
(e.g. X235, Y4785)



# Landscape units: **accuracy matters;**

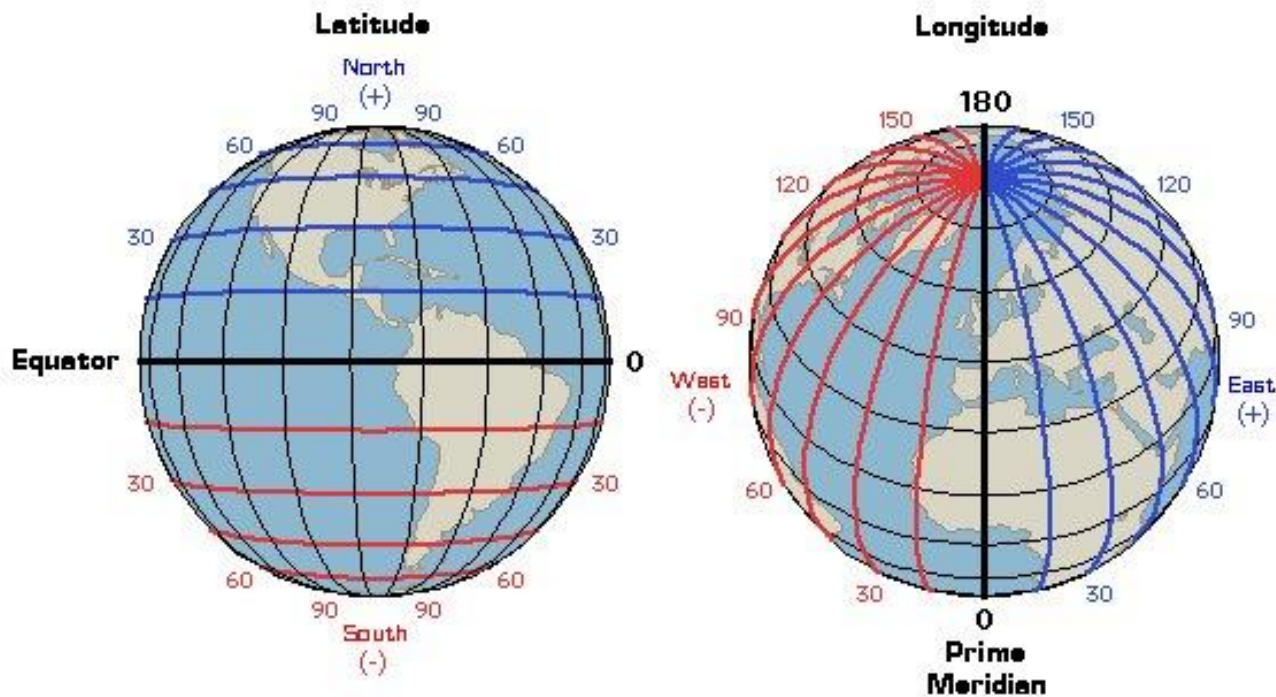


At this scale, you need  
precision and accuracy  
of  $< 5$  km

# Coordinate System

The main format is Latitude and Longitude,  
Generally in **decimal degrees**

However it produces **cells** of different sizes



## Coordinate systems

Different **projections** are used to represent a given region



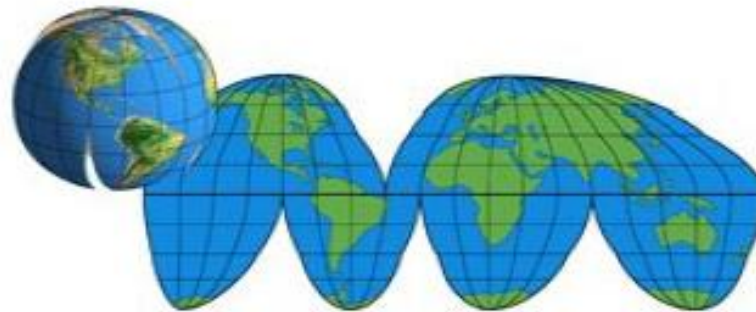
conic projection



cylindrical projection



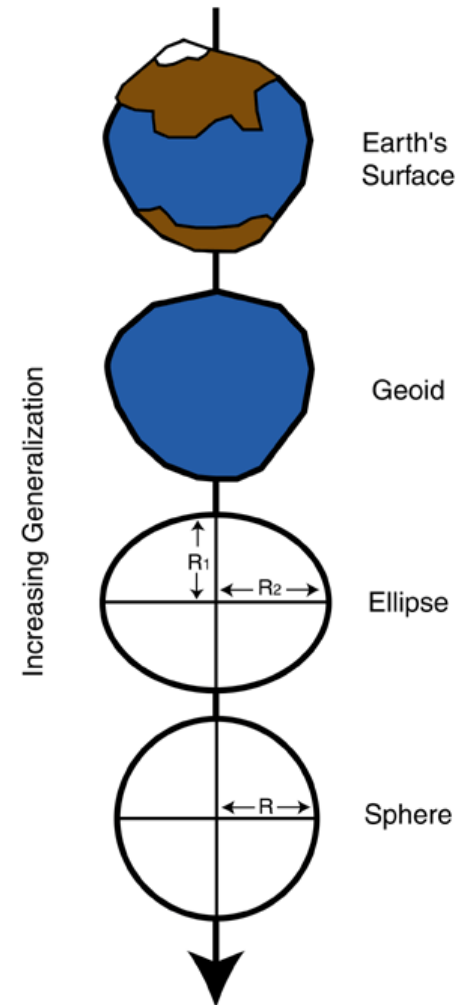
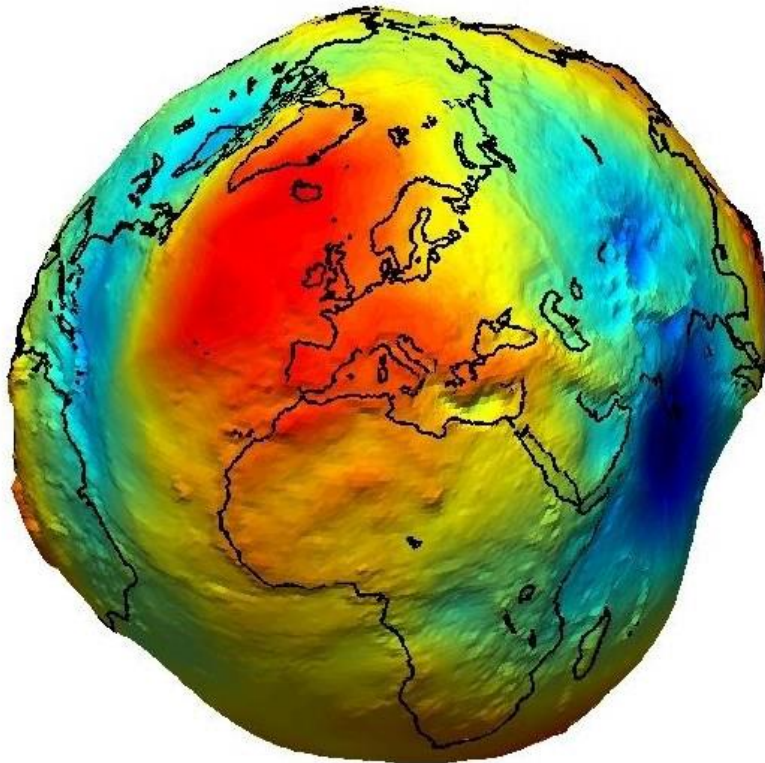
plane projection



interrupted projection

## Coordinate systems

The projection is corrected with the **DATUM**  
to represent the real surface of the Earth  
In Europe: datum **ETRS89** is the new standard



## IMPLICATIONS

1. Verify the **reference system** for your coordinates
2. Verify the **datum** used for that reference system
3. Try to understand the **accuracy** of that coordinates
4. You can **transform** coordinates and datums in GIS
5. The same procedure for VECTORIAL and RASTER layers

# Our data

We will use geographical coordinates (log/lat) in **decimal degrees**  
 In DIVA-GIS manual it is indicated how to transform from DDGGSS

**The 19 Bioclimatic Variables<sup>9</sup>**

- BIO1 = Annual mean temperature
- BIO2 = Mean diurnal range (max temp – min temp) (monthly average)
- BIO3 = Isothermality (BIO1/BIO7) \* 100
- BIO4 = Temperature Seasonality (Coefficient of Variation)
- BIO5 = Max Temperature of Warmest Period
- BIO6 = Min Temperature of Coldest Period
- BIO7 = Temperature Annual Range (BIO5-BIO6)
- BIO8 = Mean Temperature of Wettest Quarter
- BIO9 = Mean Temperature of Driest Quarter
- BIO10 = Mean Temperature of Warmest Quarter
- BIO11 = Mean Temperature of Coldest Quarter
- BIO12 = Annual Precipitation
- BIO13 = Precipitation of Wettest Period
- BIO14 = Precipitation of Driest Period
- BIO15 = Precipitation Seasonality (Coefficient of Variation)
- BIO16 = Precipitation of Wettest Quarter
- BIO17 = Precipitation of Driest Quarter
- BIO18 = Precipitation of Warmest Quarter
- BIO19 = Precipitation of Coldest Quarter

$$\text{Decimal degrees} = [(\text{Degrees } (^\circ) + \text{Minutes } (') / 60 + \text{Seconds } (") / 3600)] * H$$

H = 1 when the coordinate is in the Eastern (E) or Northern (N) Hemisphere  
 H = -1 when the coordinate is in the Western (W) or Southern (S) Hemisphere

Longitude	Degrees, Minutes & Seconds	Decimal Degrees	Latitude	Degrees, Minutes & Seconds	Decimal Degrees
Eastern Hemisphere	60°20'15" E	+ 60.3375	Northern Hemisphere	24°00'45" N	+ 24.0125
Western Hemisphere	60°20'15" W	- 60.3375	Southern Hemisphere	24°00'45" S	- 24.0125



## The PRACTICE

Prepare the coordinates in EXCEL

Create a **SHAPEFILE** of occurrences in Diva-GIS

Import the raster variables from **ASCII** file to DIVA-GIS

**Save** the layers and the project in your computer

**Check** the extent and grain of rasters and the accuracy of data

ADVANCED STUDENTS:

Revision of projections and datum, spatial autocorrelation in ArcGIS