A **Geographic Information System (GIS)** integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.

A GIS helps you answer questions and solve problems by looking at your data in a way that is quickly understood and easily shared.

GIS technology can be integrated into any enterprise information system framework.
WHAT CAN YOU DO WITH GIS?

- Map Where Things Are
- Map Quantities
- Map Densities
- Find What's Inside
- Find What's Nearby
- Map Change

Step 1: Framing the Question
Step 2: Find Data
Step 3: Examine the Data
Step 4: Analyze the Data
Step 5: Sharing and Presenting
Geographic Information Systems (GIS) are specialized computer programs designed to storage, manipulates, display and analyze geospatial data.
The region of interest is subdivided into a network of such cells of uniform size and shape; each unit in then encoded with a single category or value (attribute).

Remote Sensing data are collected and presented in raster format.
Basic data structures

Vector

It is stored as points, lines and polygons.

- **Points** - X and Y coordinates
- **Lines** - connected points
- **Polygons** - line features that are connected to form an area

Which is the best format?
Examples of data that can be integrated in a GIS

- Orthorectified Aerial photos
- Satellite images
  - Image products
- Digital Elevation Models (DEM)
- Demographic data
- Physical features
  - Soil types
  - Geology
- Research field data

GIS Software
Specialized programs adapted for the manipulation of geographic data

Image display
Display data in a map-like format so that geographic patterns and interrelationships are visible

Overlay Capability
- Visual overlay
  Superimpose two (or more) layers on the screen so that the two patterns can be seen together in a single image.
- Logical and arithmetic overlay
  Analyst can define new variables or categories based upon the matching of different overlays at each point of the map

Projection conversion
Provides the ability to change from one map projection or geographic reference system to another
Map Projections

A mathematical model that transforms locations on the globe (curve surface) to locations on a two-dimensional (flat) surface

Cause Distortions

- Area
- Distance
- Shape
- Direction

Examples:

- Geographic Coordinate System (GCS)-Lat/Long
- State Plane Coordinate System – will be in either feet or meters
- Universal Transverse Mercator
- Albers
- Lambert

Spatial Reference Systems

How to choose the best spatial reference systems?

- Choose the projection that better preserve the properties to be analyze
- Evaluate the more common map projection used with the data-set to be used

Define vs. Project vs. Re-project
Examples of Software

- IDRISI (www.clarklabs.org)
- MapInfo (www.pbinsight.com/welcome/mapinfo/)
- GRASS (grass.fbk.eu)
- ArcGIS (www.esri.com/software/arcgis)

ArcGIS

- Latest version: 10.0
- Three levels of license: ArcInfo, ArcEditor and ArcView
- Applications:
  - ArcMap- used to create maps, view, edit, and analyze spatial data.
  - ArcScene- allows you to overlay many layers of data in a 3D environment
  - ArcTool box- has tools for geoprocessing, data conversion, and defining and changing map projections
  - ArcCatalog-used to manage and organize GIS data, preview datasets, view and manage metadata.
ArcGIS-Basic Terms

- **Attribute Table** - are associated with a class of geographic features, such as wells or roads. Each row represents a geographic feature.

- **Geo-databases** - the common data storage and management framework for ArcGIS and can be utilized wherever it is needed.

- **Coverage** - A spatial dataset containing a common feature type.

- **Shapefiles** - A set of files that contain a set of points, arcs, or polygons (or features) that hold tabular data and a spatial location. Files: *.shp, *.sbx, *.sbn, *.dbh, *.prj

EXAMPLES OF GIS APPLICATIONS
Preparing a GIS for an area of interest
(Browse and download data using different resources, re-project, categorize and clip layers, add data to attribute tables)

Importing bathymetric (XYZ) data
(Prepare table using Excel, Import using "Add XY data" tool)
Generating raster surfaces and contours from point data
(Spatial Analyst extension: Topo to Raster and Contour tools)

Incorporating field data to a GIS
(Use of GPS unit)
Data set preparation for interpolation analysis

Example: Changes in salinity along the Mayagüez Bay
(Spatial Analyst: Interpolate to raster)
Maps Preparation

Visualization of layers using 3D approach (3D Analyst: ArcScene)
bb620 at 1 meter

bb620 at 2 meters
Example: Shoreline changes analysis
(Georeferentiation, Digitalization, measurement tools)

Alejandra Rodríguez, undergraduate research
Superficially, remote sensing and GIS appear to form separate dimensions of a single activity.

They…

- Share common data
- Use many similar or interrelated analytical tools
- Use similar technology and software
- Reflect a similar spatial perspective
Working with vectors in ENVI

- Plot vector points with different sizes for attribute values
- Adding ASCII Points to Vector Layers
- Calculate an area under a vector when it is overlaying an image in the display
- Exporting Vector Locations to GCPs
- Exporting Vector Layers to...
  - Shapefiles
  - Geodatabase
- Calculate a buffer zone image in which the value of every pixel is defined as the distance from that pixel to the selected vector layers

Methods for incorporating remotely sensed data into a GIS

- Manual interpretation of aerial images or satellite images
- Digital remote sensing are analyzed or classified using automated methods and then incorporated in a GIS
- Digital remote sensing are entered directly in their form as data into the GIS
Mission Planning
Planning for acquisition of remote sensing data requires use of an accurate planimetric base for the region of interest.

GIS offers accurate planimetric representations of...
- Landscape
- Topography
- Landmarks (e.g. transportation, drainage)
- Thematic information

Ancillary Data
Because GIS and Remote Sensing data can share compatible data structures and formats, it is possible to bring them together for analysis.

*Example: Coastal lines*

Now software facilitates the methods used to export an import data from one system to another.

Collection, Organization and Visualization of Reference data
Often GIS applications provide an effective framework for organizing and presenting geospatial data
Contribution of Remote Sensing to GIS

Remote Sensing Imagery Provides Thematic Layers for GIS
- Land Use
- Specific roads networks
- Basic infrastructure of urban regions

Remote Sensing Imagery Provides a Backdrop for GIS
Example: Use of Landsat as reference

Remote Sensing Imagery Provides a Means of Updating GIS
Remote Sensing is an important source of recent information without incurring the expense of a complete resurvey.

MOBILE GIS
The increasing portability of GPS receivers has enabled laptops and PDAs to link precise, real-time, locational information to a GIS.
- Enter new data as it is directly observed
- Verify or update information already in the system
- Valuable for registering digital images or satellite imagery
- Provides immediate on-site access to spatial data in the field
WEB-BASED GIS

- Government and Private agencies to organize the data such that each department can post its own data to a common georeferenced database

- Special software are designed to publish GIS data bases in the internet using a map-like interface
  - Example: ArcIMS

http://gersview.uprm.edu