

Introduction to Geomatics

Prof Dr. Füsun BALIK Şanlı Yıldız Technical Uiversity
Doç. Dr. Saygın ABDİKAN- Hacettepe University

2016-2017 Öğretim Yılı Güz Dönemi

- “*géomatique*”
 - Geo (Earth) + informatics
- **Geodesy + Geoinformatics**
- “**Geomatics**: *The mathematics of the earth; the science of the collection, analysis, and interpretation of data, especially instrumental data, relating to the earth's surface*” . Oxford Dictionary

What is Geomatics?

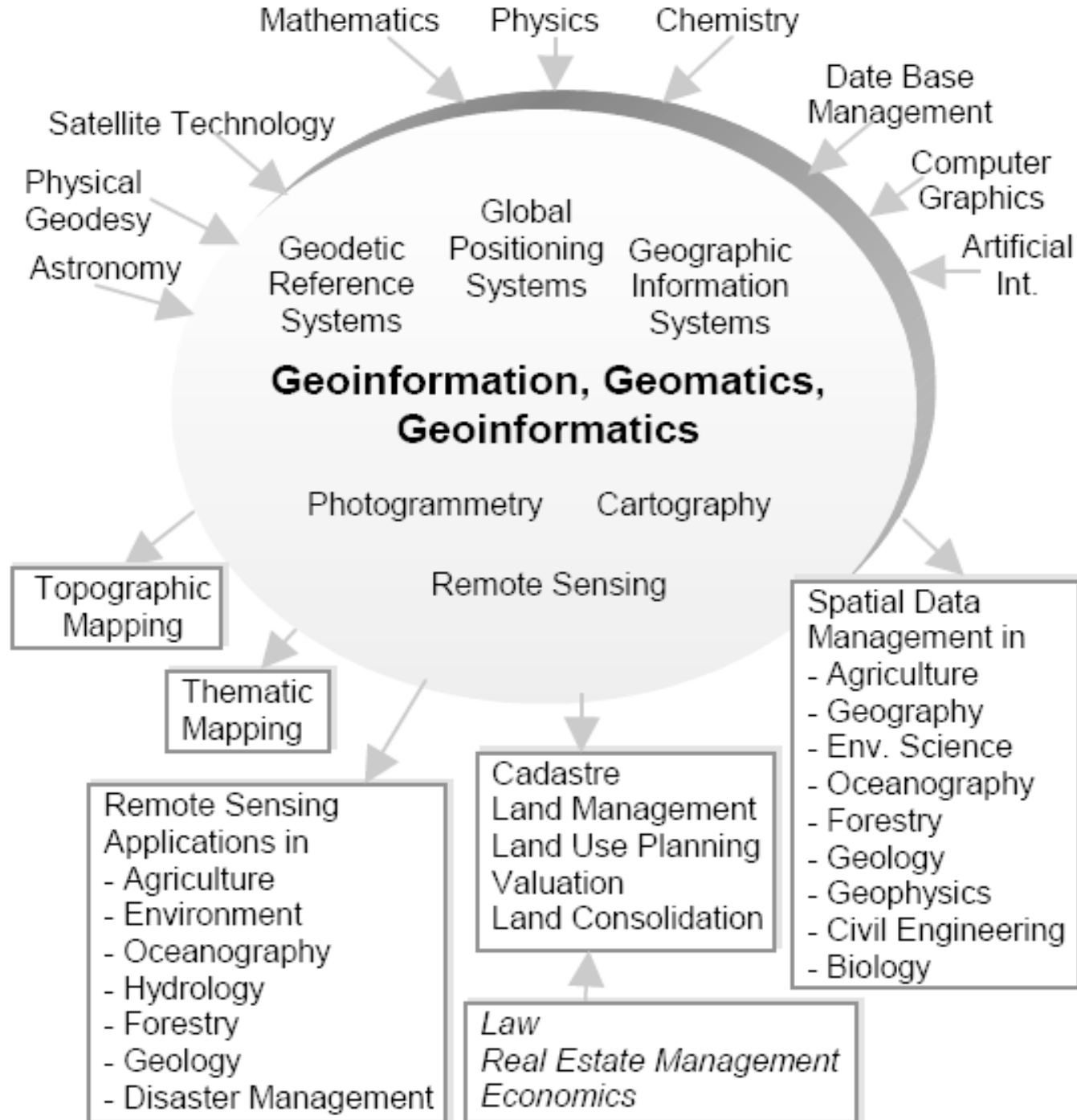
- Geomatic Engineering is a rapidly developing discipline that focuses on spatial information
- Geomatics Engineers work with state of the art technology
 - Geodesy
 - Digital photogrammetry
 - Remote sensing
 - Digital cartography
 - Geographic information systems
 - Spatial analysis & modeling
 - Global positioning systems
 - Computer vision, digital image processing
 - Land management

- Geomatic Engineering is developing the science and creating new uses for the technology developed
- The word geomatics describes the integrated approach of
 - Measurement
 - Analysis
 - Management
 - Storage and
 - Display of spatial Earth related data in digital form
- It can be said that geomatics is based on spatial information technology

- Besides it also involves

- Pyhsical
- Social
- Biological
- Economical
- Business

sciences with respect to mathematical and logical relationships



The graduates of Geomatic Engineering work in a range of organizations

- Specialist land, air and offshore mapping companies,
- Central and local government agencies,
- Cartographic publishers,
- Suppliers of computer-based mapping technology and GIS companies,
- Civil engineering contractors,
- Oil exploration multinationals and geophysical consultants.

The questions that investigated by geomatics engineering (surveying engineering)

- How do satellite navigation systems work?
- How do we know the Earth's continents move?
- If we look at the Earth from space what can we see?
- How do we make maps of the land and sea?

What do geomatics engineers use?

- **Hardware:**
 - Computers and networks
 - Surveying and geodetic instruments
 - Photogrammetric workstations
 - Visualization tools
- **Software:**
 - GIS/CAD
 - Digital image processing
 - Satellite positioning and GPS

*GIS: Geographic Information Systems

*CAD: Computer Aided Design

*GPS: Global Positioning Systems

Which devices do we use?

and devices...

- Total Stations
- Stereo Plotters
- Global Positioning Satellite Receivers
- Data Collectors
- Computers
- Software
 - CAD
 - GIS
 - Database



How do we use advanced technologies?

- High precision geodetic measurement systems and advanced methods of processing
- Application of sensor technology in spatial data acquisition
- Implementing GIS solutions in urban cadaster
- 3D space modeling through modern mapping techniques
- Monitoring and probabilistic analyzing of environment systems
- Use satellite, laser and 3D technology to create the maps of tomorrow

Surveying

- It is the science, art, and technology of determining the relative positions of points above, on or beneath the Earth's surface
- Geomatics embraces the traditional areas of surveying and mapping
 - Topographic surveying
 - Geodesy
 - Cadastral surveying
 - Photogrammetry
 - Hydrography

Devisions in YTU Geomatic Engineering Department:

- Geodesy
- Engineering Surveying
- Photogrammetry
- Cadastre/Boundary Surveying/
- Land Management
- Cartography

Geodesy

- Traditionally it is the shape, size, and the gravity field of the Earth.

Nowadays

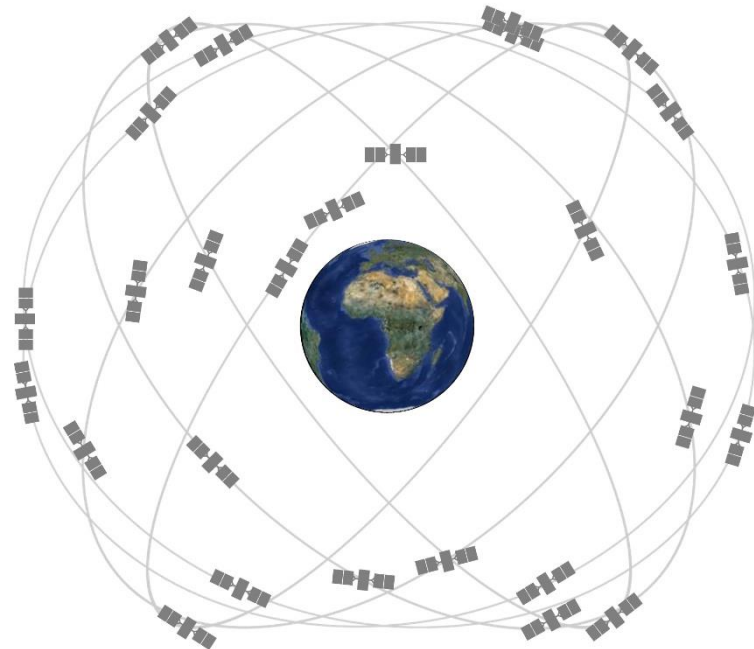
- Monitoring the **solid Earth** (displacement, subsidence or deformation due to tectonic or other natural phenomena as well as human activity).



- monitoring variations in the **liquid Earth** (sea-level rise, ice sheets);
- monitoring **variations** in the **Earth's rotation** (polar motion, the length of the day);
- monitoring the **atmosphere** with satellite geodetic techniques (ionosphere and troposphere composition and physical state);
- monitoring the **temporal variations** in the Earth's gravity field;
- determining **satellite orbits** (including Earth observation and navigation satellites);
- determining **positions** - and their changes with time - of points on or above the surface of the Earth

GPS

- Global Positioning System
- A navigation system developed and maintained by the U.S Dept. of Defense
- Satellite based system
- Consists of 3 segments:
 - Space
 - Control
 - Users



- Space segment: GPS constellation
- 31 satellites currently operational in orbit
- Orbital period 12 hours (satellites pass over the same locations or almost the same locations every day.) Each satellite circles the Earth twice a day.
- Four satellites must be in view of the receiver for it to compute four unknown quantities (three position coordinates and clock deviation from satellite time).

- Map projections and geodetic datum
- Ground motion
- Geohazards and the deformation of the Earth
- Seismic and gravitational survey
- Precise positioning in agriculture, environment, marine, rail, road and

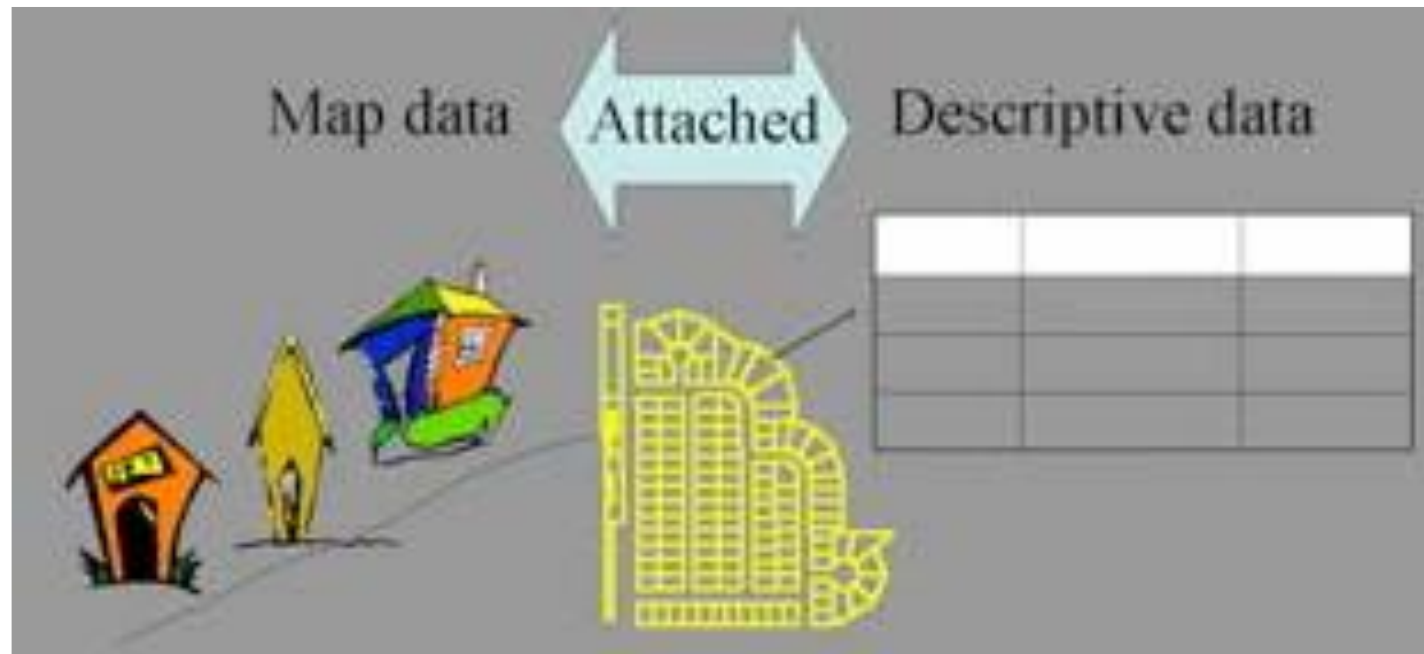


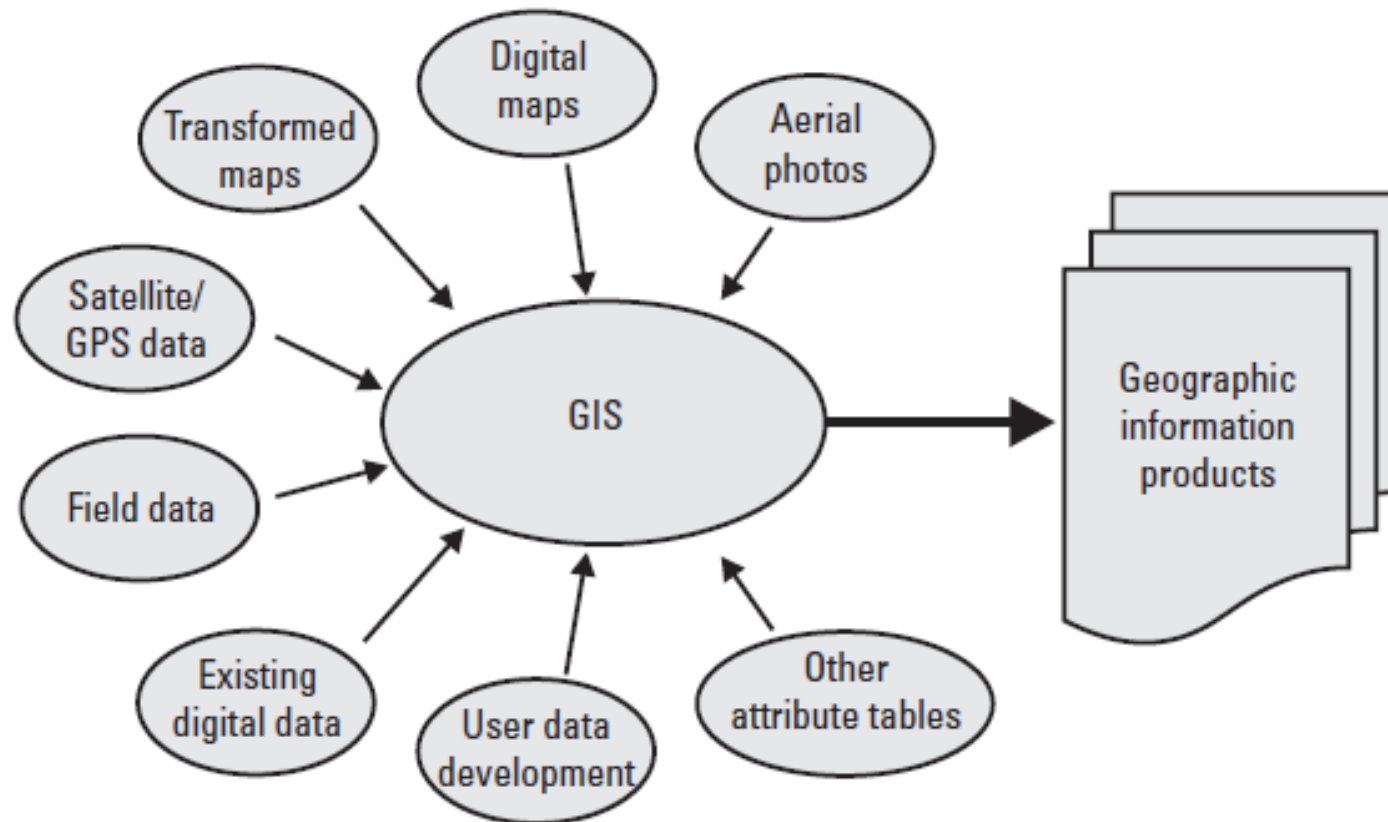
GIS

- A geographic information system (GIS) is a computer system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data.
- Database technology can manage multi-dimensional data

GIS

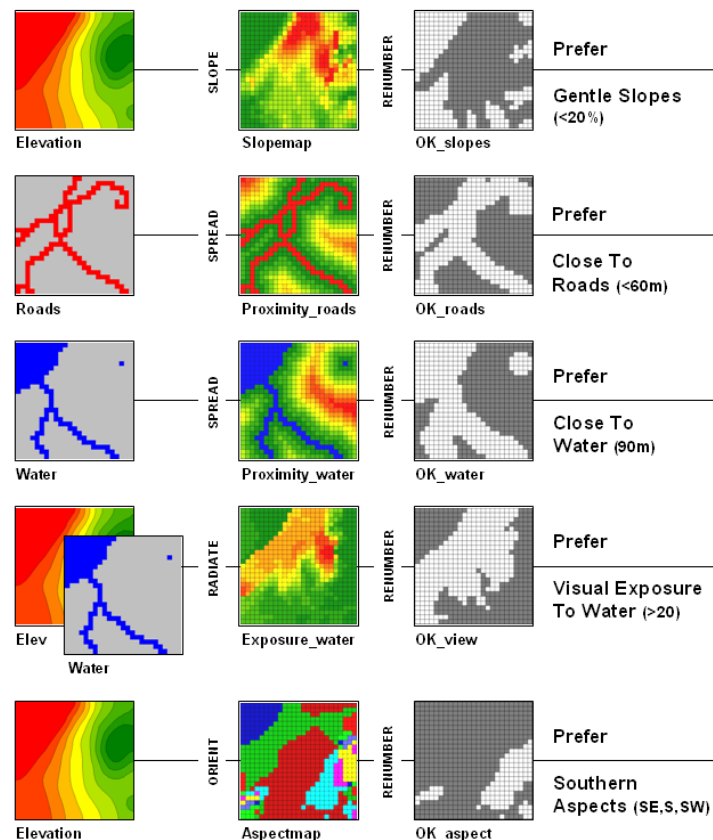
- A digital model of the real world



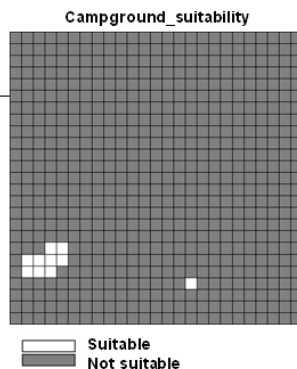
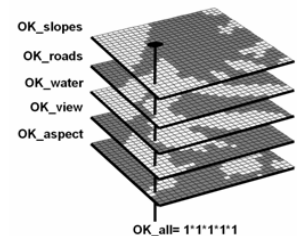


GIS application examples

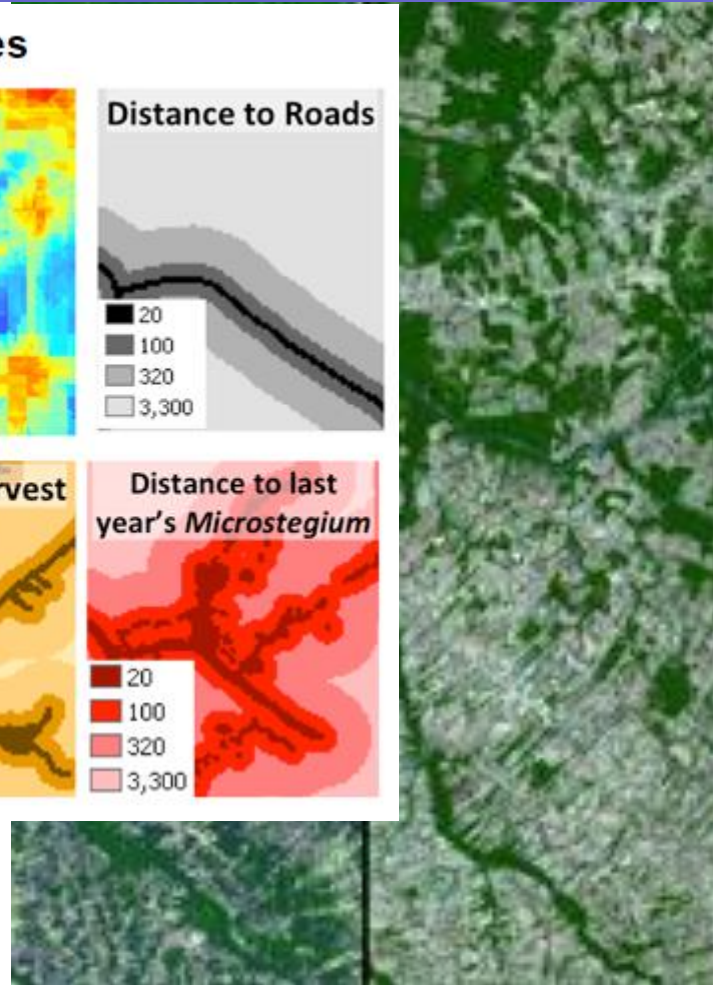
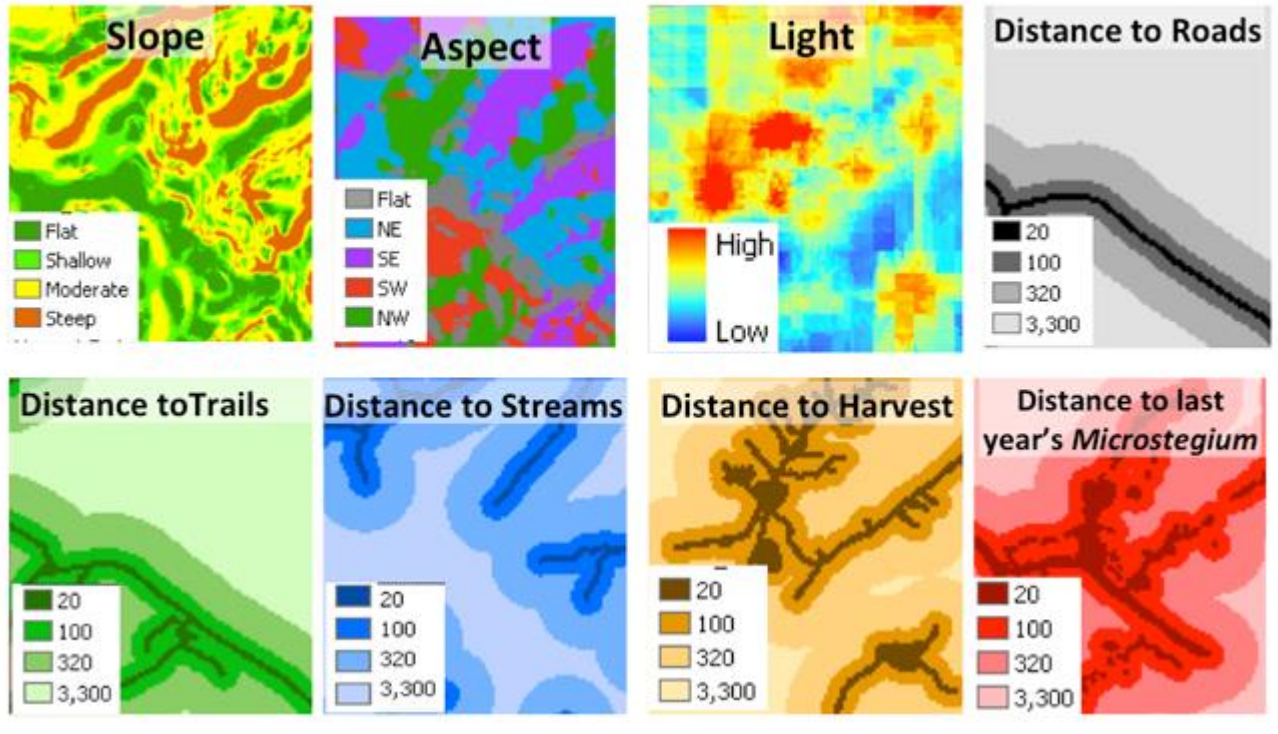
- Land suitability analysis
- Prediction modeling
- Time series analysis
- Change detection
- Digital landscape



... Suitability Modeling uses map analysis techniques to evaluate spatial criteria for appropriate locations



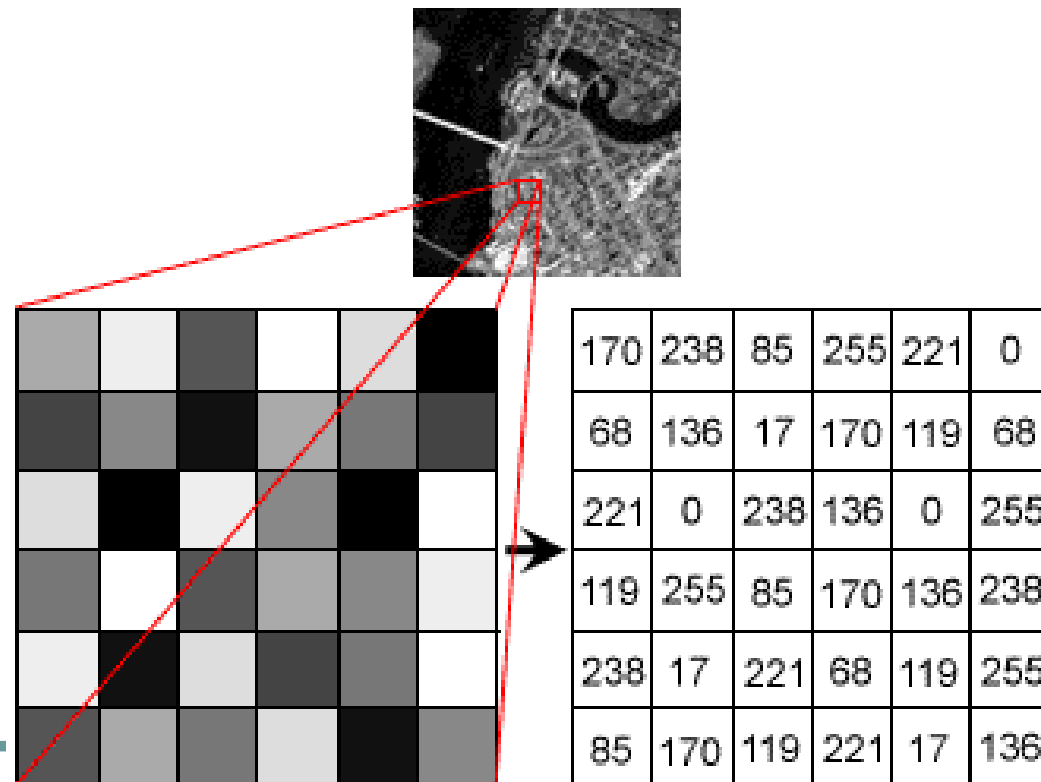
Model Predictor Variables



Before and after imagery of Amazon deforestation

Digital image & mapping

- Pixel
- Digital Number

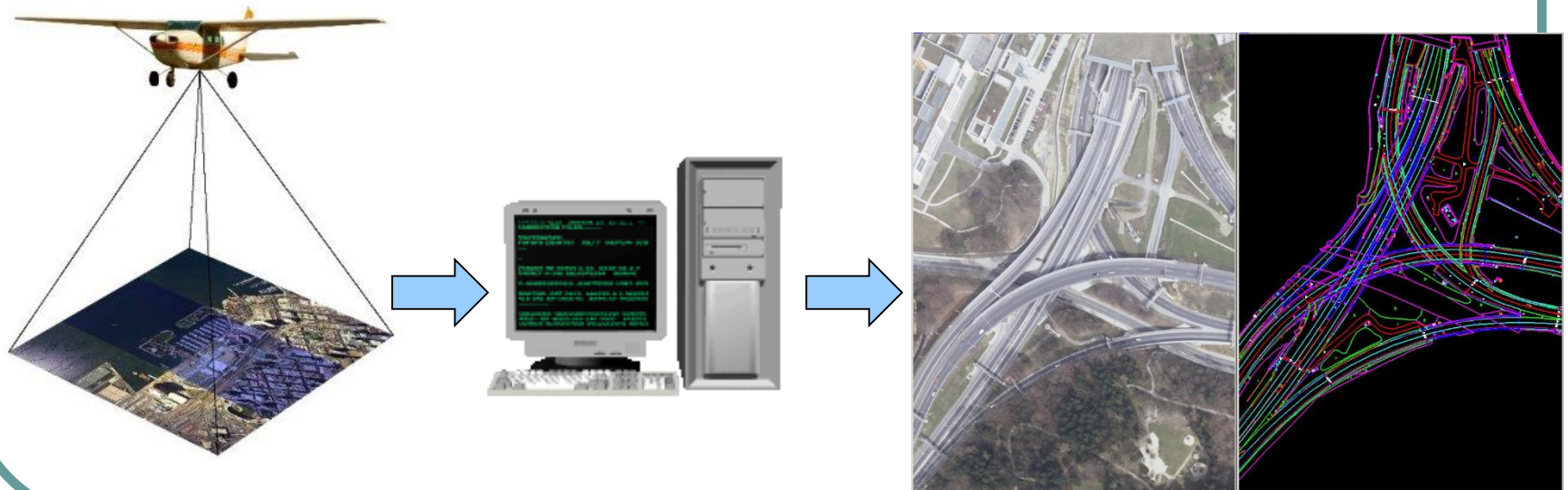


Photogrammetry

- **Photogrammetry** is the art and science of making accurate measurements by means of aerial photography:
 - Analog photogrammetry (using films: hard-copy photos)
 - Analytical photogrammetry
 - Digital photogrammetry (digital images)

- Flight planning
- Ground Control Points - GCP
- Equipment
- Aerial cameras

- Orthophoto
- Stereo model
- Digital elevation model

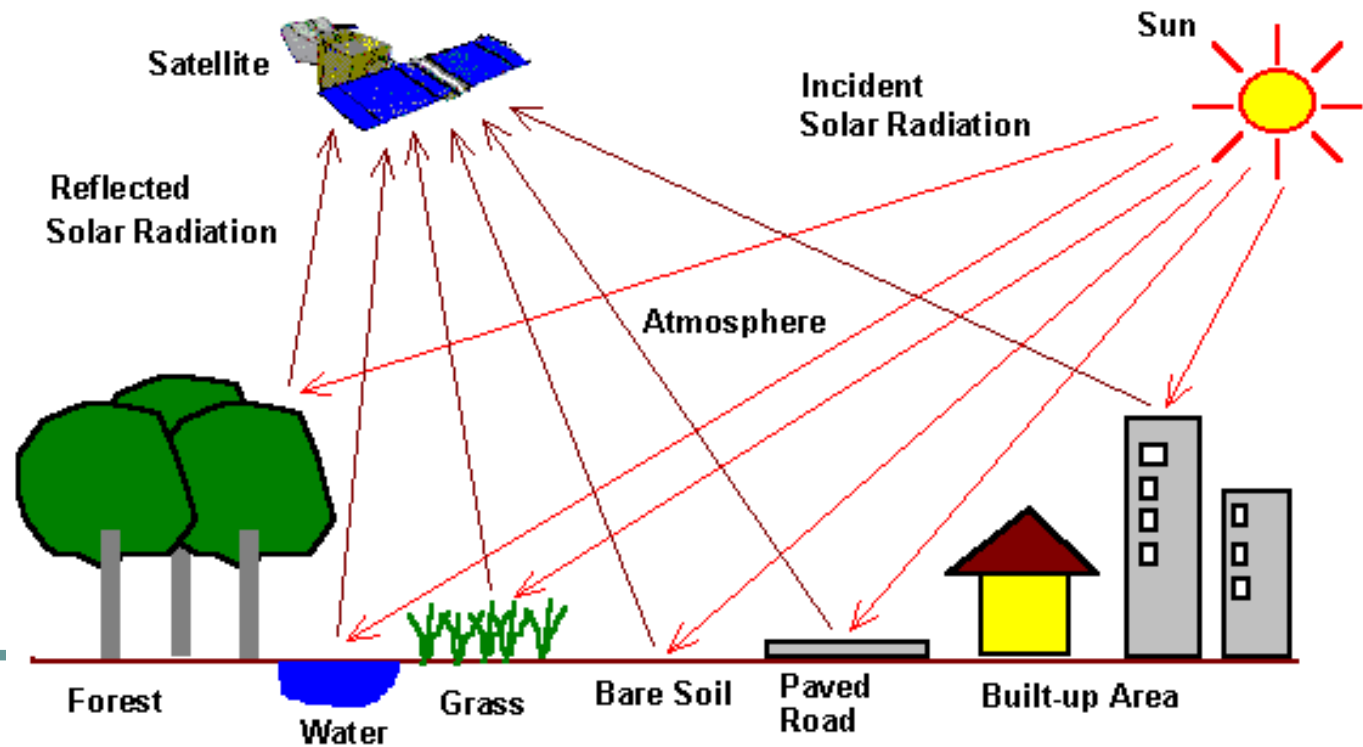


Remote Sensing

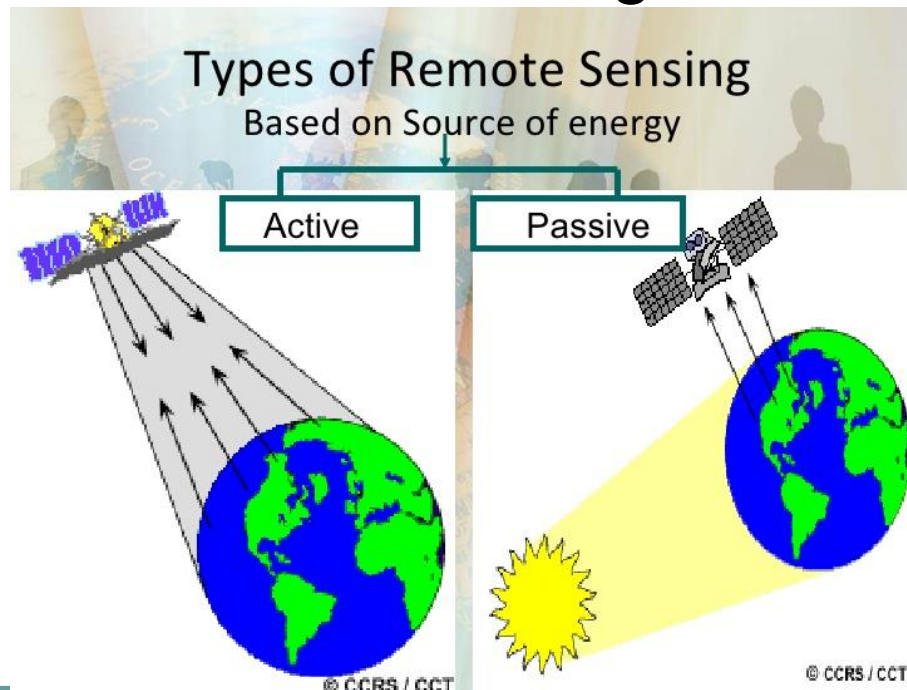
- Collection of data without being in physical contact



Human eye



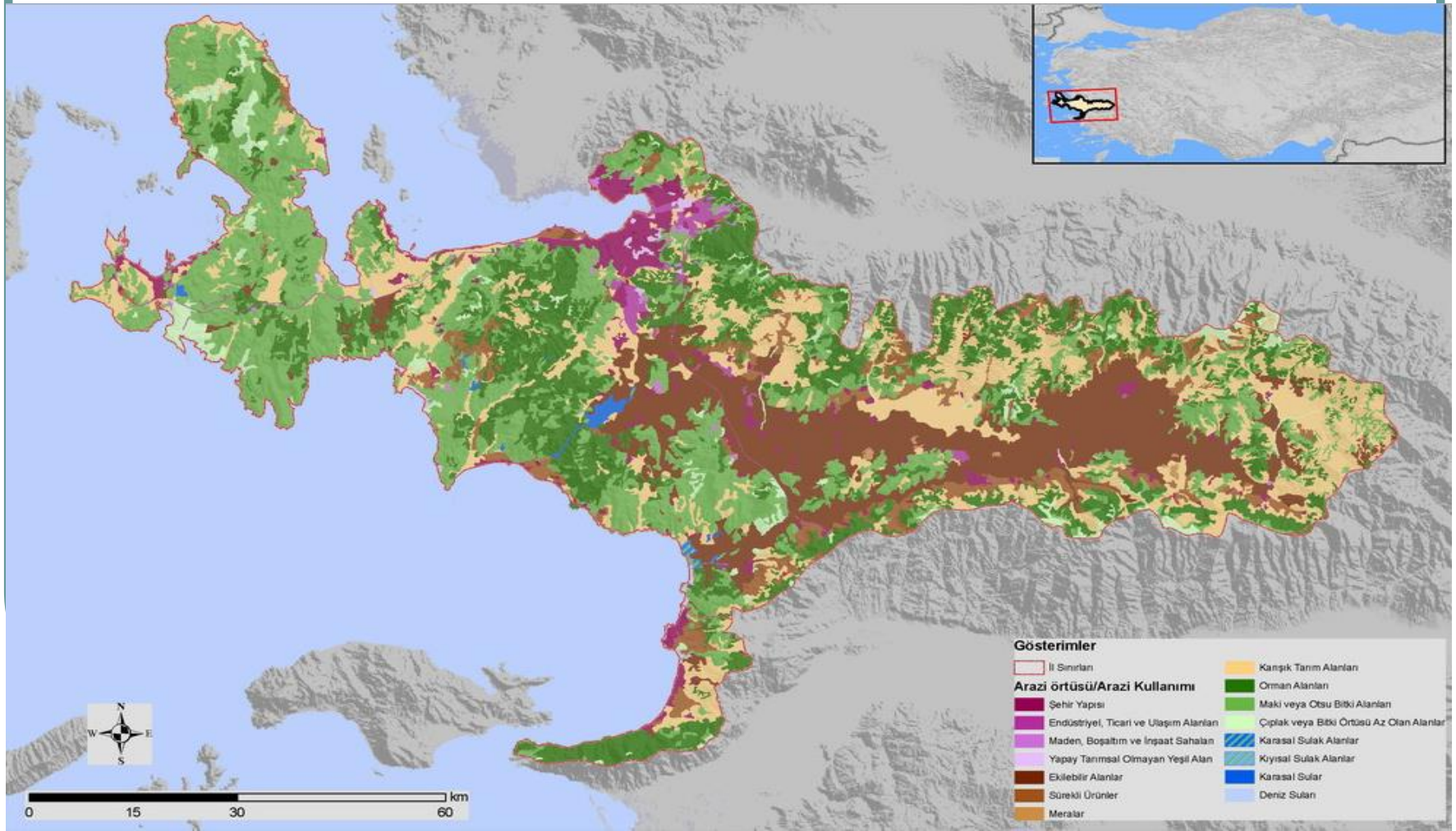
- Electromagnetic spectrum
- Visible & infrared bands & thermal
- Microwave remote sensing



Remote Sensing

- Satellite imagery
- Sensor types
- Passive / active systems
- Lidar (Light detection and ranging)
- Radar (Radio detection and ranging)
- Multispectral / Hyperspectral imagery
- Bathymetry
- Thermal imagery

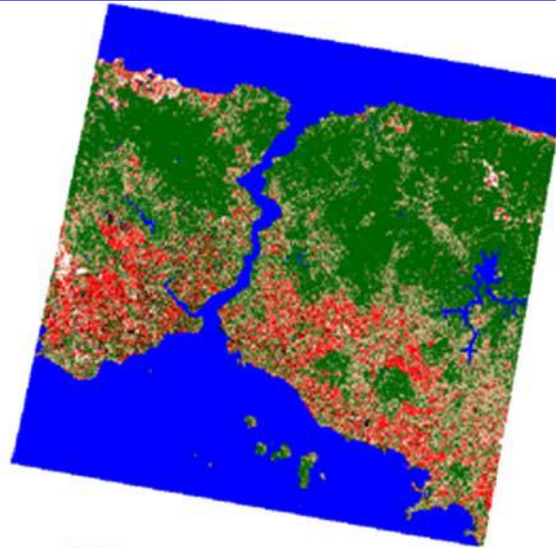
● Land use/cover maps



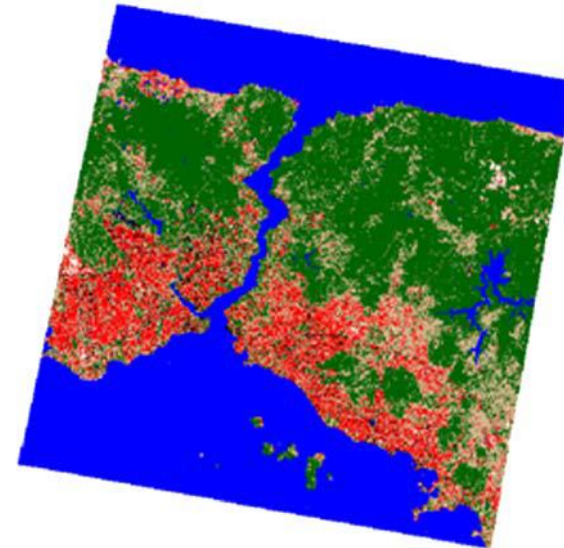
Temporal analysis – Change detection

Fusun Balik Sanli & Filiz Bektas
Balcik & Cigdem Goksel, 2007,
Environ Monit Assess
Defining temporal spatial
patterns of mega city Istanbul
to see the impacts of increasing
population

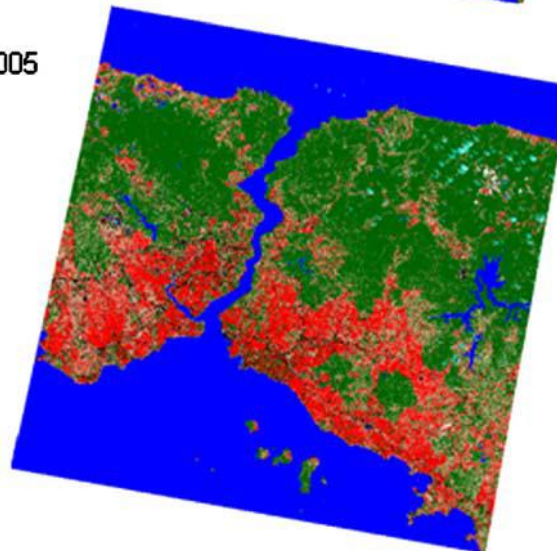
1992



1997

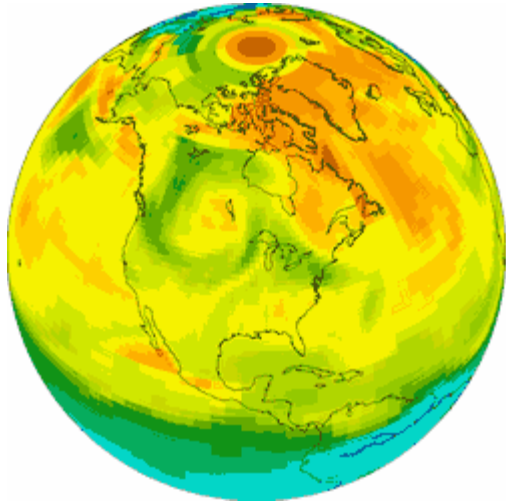


2005

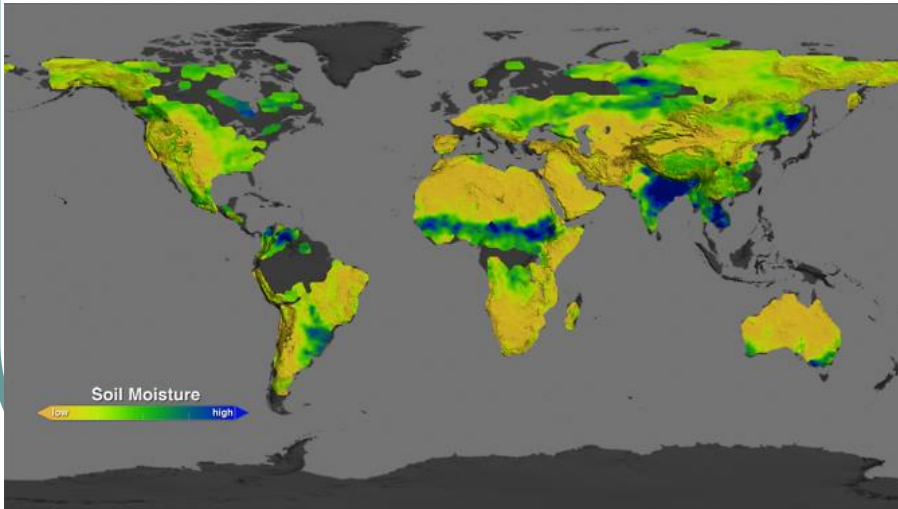


- Water Surface
- Urban Area
- Bare Land
- Forest & Green Area
- Mining Area
- Road

Global monitoring



CarbonTracker CO2 weather for June-July, 2008. Warm colors show high atmospheric CO2 concentrations, and cool colors show low concentrations.



The soil moisture conditions around the planet were like in August 2013: dry areas are represented in the brown scale, while wetter areas are in blue and green.

Cartography

- It is the study and practice of making maps.
- What is a map?
 - “a symbolized image of geographic reality, representing selected features or characteristics resulting from the creative efforts of cartographers and designed for use when spatial relationships are of special relevance.” (ICA, 1995)

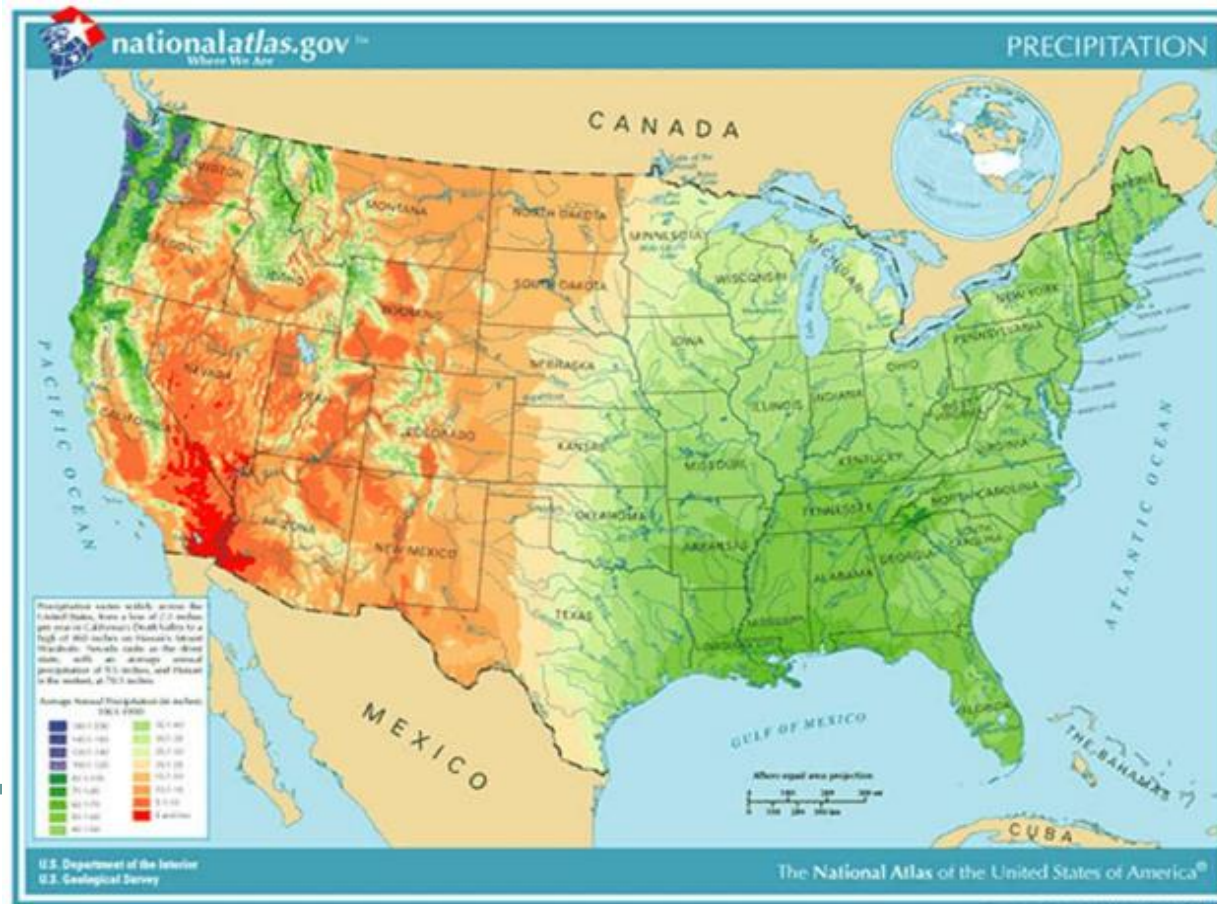
- Function of maps in general:
 - Storage medium for information
 - Provides a picture of the world to help understand
 - spatial patterns
 - spatial relationships
 - environmental complexity

- Map scale (Large/small scale)
- Components of a map
- Generalization
- Exaggeration
- Map projections
- Symbols, legend

- Types of maps:
 - Reference maps: planimetric & topographic



- Thematic maps: spatial relations & patterns: soils, forest etc.
- Specific geographic themes, oriented toward specific audiences



Mercator's Arctic Map

1595

- Passages
through the
North Pole



References

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- Ipbuker C. 2010. The Reason of Changing The Name to “Geomatics” FIG Congress, Sydney, Australia, 11-16 April 2010
- Presentation of Department of geomatics university of Alaska Anchorage