Geographic information systems: data versus information. Introduction to remote sensing

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Geographic Information Systems: data *versus* information. Introduction to Remote Sensing

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Abstract. In a modern society, decision-making process realised by managers or planners must be based on true information which has been obtained from reliable and consistent data. Geographic Information Systems are tools that allows us to convert pre-existing "data" into "information" Remote sensing is defined as the ability to obtain information from an object without physical contact with it. Remote sensing term is restricted to all methods that use the reflected or irradiated electromagnetic energy of objects.

Keywords. GIS – Data – Information – Remote sensing.

Systèmes d'information géographique : donnés* vs *information. Introduction á la télédétection

Résumé. *Dans une société moderne, le processus de prise de décisions qui font les gestionnaires et les planificateurs doit être fondé sur une information véritable, qui au même temp a été obtenu des données fiables et cohérentes. Les Systèmes d'information géographique sont des outils qui nous permettent de convertir les données existantes en information. La télédétection est définie comme la capacité d'obtenir des informations provenant d'un objet sans contact physique avec lui. Le terme Télédétection se limite à toutes les méthodes qui utilisent la réflexion ou l'irradiation d'énergie électromagnétique des objets.*

Mots-clés. *SIG – Donnés – Information – Télédétection.*

I – GIS: data *vs* information

In a modern society, the "decision-making" process to be carried out by managers or planners must be based on "true information", which has been obtained from "reliable and consistent data".

In organizations that performs a constant process of decision making, the "information" plays a decisive role, because without it would not be possible the evaluation of different alternatives.

Geographic Information Systems are tools that allow us to convert "data" into interpretable "information" (Fig. 1).

BURROUGH (1986) defines a Geographic Information System: *is a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes.*

Geographic data describe the elements of real World in terms of: their position in space with respect to a coordinate system, their attributes (colour, cost, pH...) and their spatial relationships which shows us how they are related or how we can move between them.

Take as example a network of meteorological stations distributed by a territory that send us precipitation data each 5 minutes. This observation network provides us a huge number of measures, definitive data, which often are transformed into a list of difficult interpretation.

A GIS tool will allow to store in a structured way the data in table forms, positioning it into the territory, accumulating it to make data more representative, interpolating it to get data from those

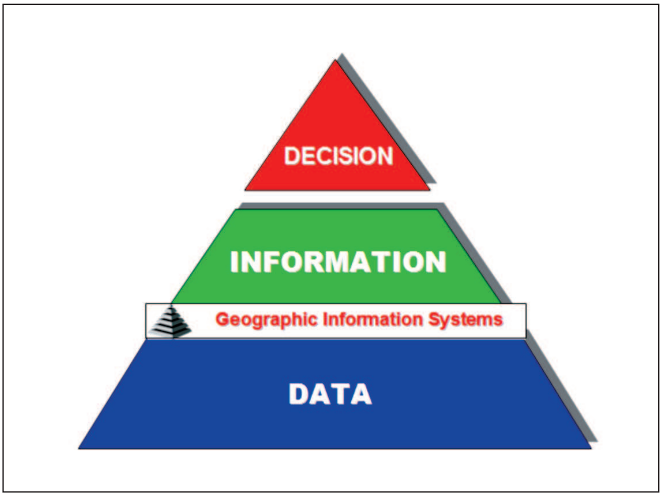

Fig. 1. Conceptual model of pyramidal decision.

areas where is not possible the observation, definitively, to convert "data" into useful "information" to the managers of the territory (Fig. 2).

Conceptually, a GIS is a relational database consisting on a graphic database linked to an alphanumeric database.

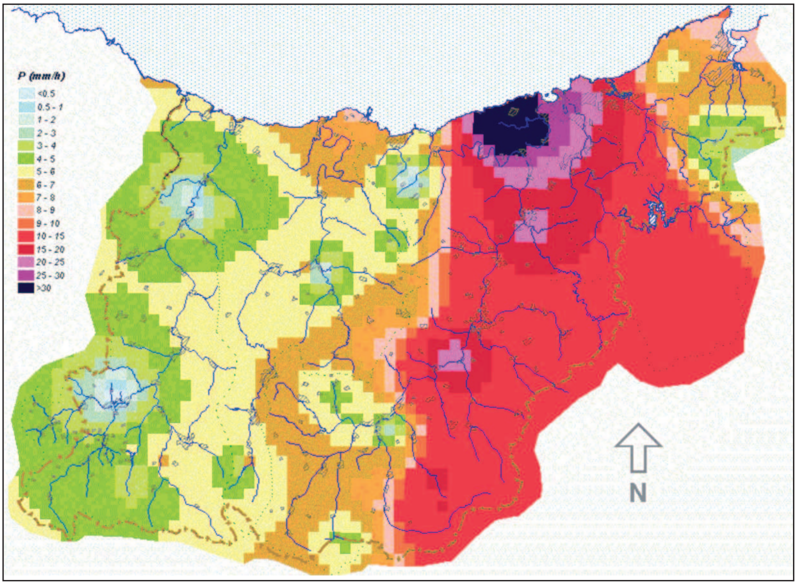

Fig. 2. Rainfall map (mm/h) obtained with punctual data from rainfall stations distributed along territory (Gipuzkoa, Spain).

When incorporating geographical entities into GIS, the digital representation is done into two different ways: Raster mode (cells) or Vectorial mode (Fig. 3).

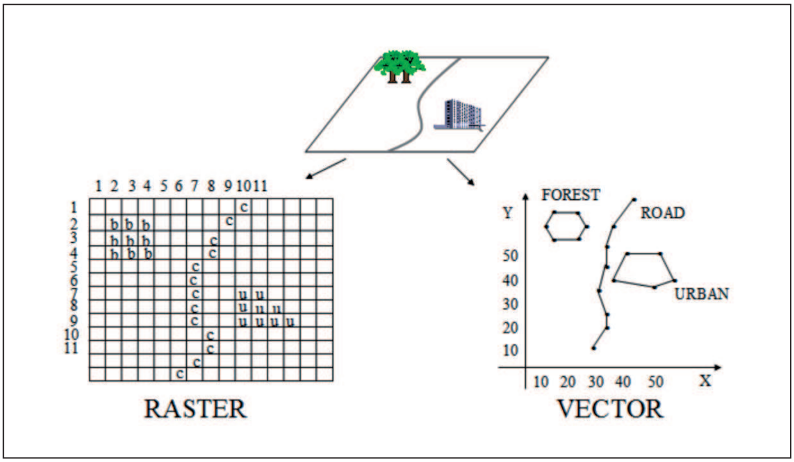

Fig. 3. Data structure into GIS.

A raster structure consists on a matrix of cells with uniform size, each of them referenced by a positional unique index (number of line and column). It contains a number or a code that represents an attribute value that has been mapped. Digital photography has a typical raster structure.

On the other hand, a vector structure represent the points thanks to a pair of coordinates; the lines by a string of coordinates, uniform or random spaced; and the areas or polygons by their edges or boundaries. Conventional mapping (geological, topographical, land use maps…) are digitally stored in vectorial mode.

Data are stored as georeferenced layers from any available source data (Fig. 4).

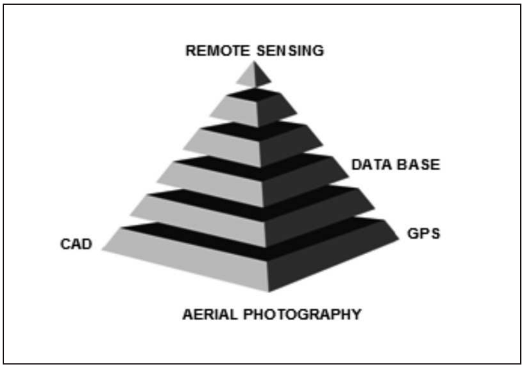

Fig. 4. Conceptual model of a GIS.

As a result of the analysis of these layers, new layers of information can be created that feed back the system. The results of the analysis are represented in alphanumerical (informs and tables) and graphical (images and maps) forms.

II – Introduction to Remote Sensing

Remote sensing is defined as the ability to obtain information about an object without physical contact with him. The term Remote sensing is restricted to those methods that use reflected or irradiated electromagnetic energy by the objects, which excludes electrical, magnetic or gravimetric parameters that measure force fields (Sabins, 1978).

This technique, which allows acquiring information of an object in distance, is based on that terrestrial surface materials have a spectral response of its own, that allows identifying them. For this, it is necessary to have instruments capable of recording the radiation from the Earth and then transform it into a signal capable of being operated in analogue (photographic products) or digital (CCTs, exabytes tapes or CDs) forms.

The laser, the radar, the multispectral scanners and the cameras are the sensors most used in Remote sensing; and the aircraft and the satellites are the platform on which to install these sensors for data acquisition.

Artifical satellites are the best viewing platform on which to install these sensors. Depending on their orbital characteristics, these satellites can be classified into three groups (Fig. 5):

(i) Geostationary satellites.

(ii) Polar orbiting satellites.

(iii) General orbit satellites.

Geostationary satellites, also called geosynchronous, are those that appear as if they were still on a fixed point on the surface. This is because the satellite is orbiting at a height such that his orbital period i(time that a satellite takes to complete an orbit around a planet) s equal to the speed of the Earth rotation.

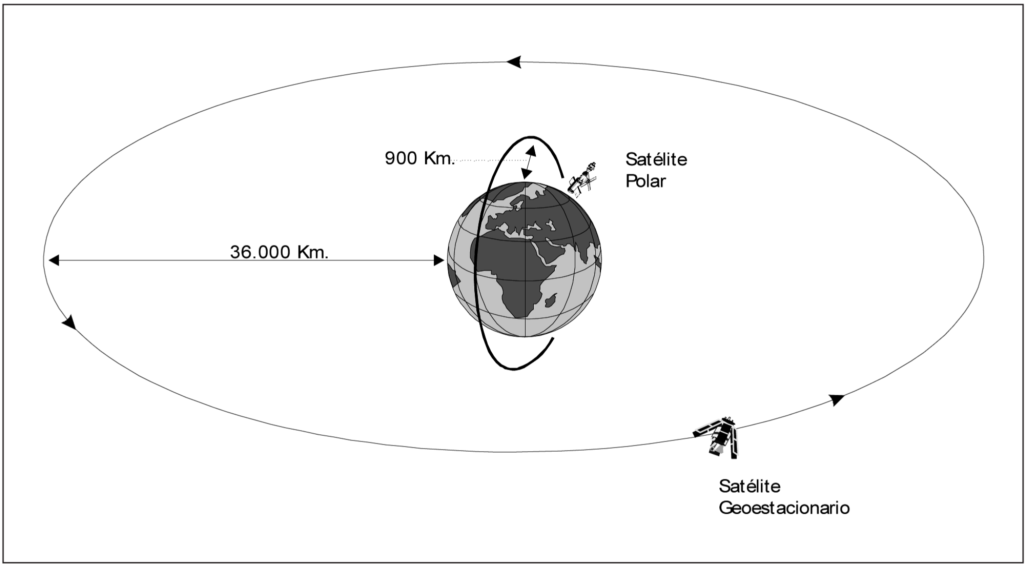

Fig. 5. Polar orbiting and geostationary Satellites (Montesinos, 1990).

This orbital altitude is about 35,800 km, that is, 5.6 times the Earth's radius (about 6,370 km). For this reason, geosynchronous orbits are equatorial or quasi-equatorial. Examples of geostationary American meteorological satellites are ATS (*Applications Technology Satellites*) and GOES (*Geostationary Operational Environmental Satellites*), or the European METEOSAT. They are characterized by low spatial resolution and the high frequency of their observations (several times a day).

Polar-orbiting satellites are also called sun-synchronous, because the angular relationship between Sun and the satellite is constant (WIDGER, 1966; PETRIE, 1970). This means that the satellite passes by the same point of the ground surface at the same time.

The three principal elements in any system of remote sensing are the sensor, the observed object and the energy flow that occurs between them. Of the types of energy flow that can occur, remote sensing uses the reflected and emitted energy (Fig. 6).

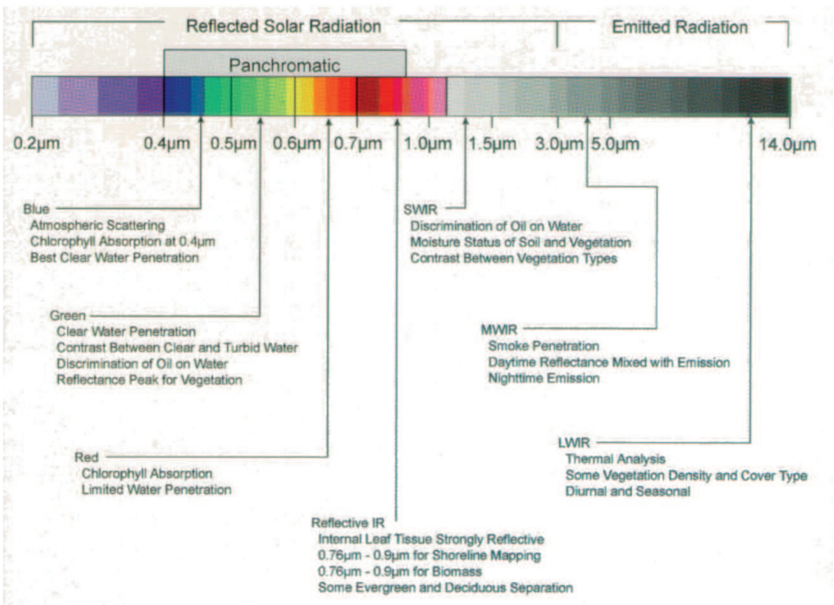

Fig. 6. The regions of the electromagnetic spectrum and their principal applications.

In remote sensing, the most widely used type of energy is the reflected by the Earth due to the solar illumination. When sun ray's strike in the Earth surface, some of this energy is absorbed and the rest is reflected back into the atmosphere by an amount dependent of the characteristics of the terrain at this point. This reflected energy flow is detected by the sensors aboard satellites and from them it is encrypted and sent to receiving stations on Earth. Passing through the atmosphere, the flow undergoes a series of interactions with the particles in it, producing modifications like absorption, dispersion… in the original reflected energy by the Earth surface.

Similarly, the observation can be based on the emitted energy by the own coverts or by the energy capable to generate their own energy flow and to collect their reflection late on the surface.

Remote sensing from satellites provides a big amount of information with particular interest in planning and management of the natural resources, whether agricultural, forestry, hydrological or mining. The information that this technique is available to us (Montesinos, 1995):

(i) *Temporal Information:* Due to their orbital characteristics, these types of satellites fly over the same area every short periods (16 days for Landsat and 25 days SPOT). This means, for example, that Landsat satellite obtained more than 20 images each year from any part of the Earth surface. To this we add that the first Landsat satellite was launched in 1972, so we have more than 800 observations available of the same point along the past 40 years.

Currently, these satellites are sending images continuously to a graphical database, thanks to this its possible not only to know past situations, but also plan future observations.

(ii) *Spatial Information:* Satellite images cover large areas of land. A Landsat scene covers about 35,000 km^2 (185 x 179 km) and SPOT, around 3,600 km^2 (60 x 60 km), allowing the integration of the study area within the physical frame to which it belongs. Spain is covered by around 50 Landsat images and 250 SPOT.

(iii) *Spectra Information:* Sensors used onboard satellites capture information not only in the visible region (which is accessible to the human eye) but also in the infrared region. This feature is especially important in the discrimination of vegetal crops, soils and lithology types.

(iv) *Radiometric Information:* Encoding electromagnetic radiation is done digitally, usually in a byte (2^8) or, which is, in a range of values ranging from 0 to 255. This digital encoding allows us to analyze the collected data by the sensors.

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