Remote Sensing — Short History (II)

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Abstract

Some important steps from preparing the Landsat program are presented and also the Roumanian contribution to the program.

Keywords: Remote-sensing, LANDSAT program, Landsat mission.

The first commercial remote sensing program was marked by the placement in orbit of the ERTS-1 (Earth ResourcesTechnology Satellite) satellite, later renamed, to outline its utility, **LANDSAT-1**. However, its preparation began much earlier.

Thus the first multispectral image was acquired during the Apollo 9 mission in 1968 on board which four Hasselblad cameras with film were mounted in an assembly so that they could be operated simultaneously. The four spectral bands were:

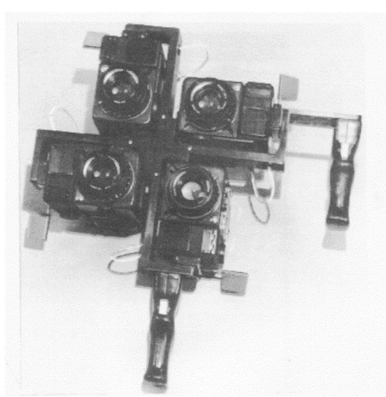

Fig. 1 Montage of four Hasselblads cameras with film, for simultaneous multispectral photography.

1. Spectral band one: blue;

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2. Spectral band two: red;
3. Spectral band three: green;
4. Spectral band four: inphfrared. (see Fig.).

This first multispectral image acquired during the Apollo 9 mission was of the San Diego area in California: (see Fig. 2).

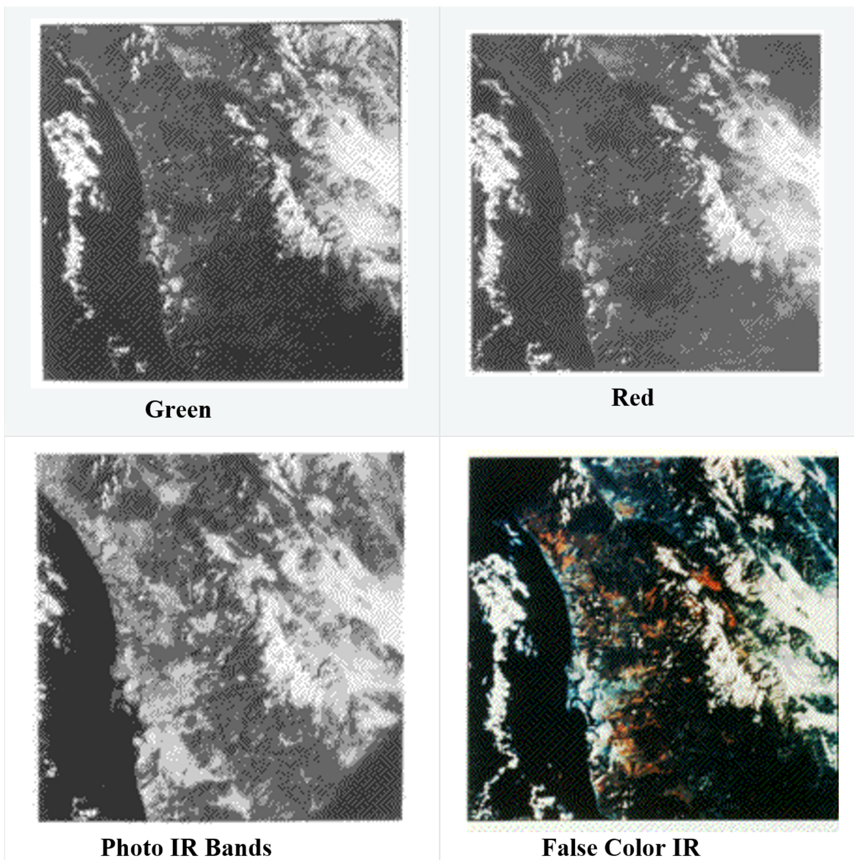


Fig. 2.

During the same period of preparation of the first LANDSAT mission, a lot of algorithms for processing the future images were studied and realized, of which we mention the transformation of the main component, as well as the determination of NDVI - the normalized difference vegetation index.

The first concerns regarding the assimilation and use of remote sensing techniques appeared in Romania, within the Department of Photogrammetry at the Faculty of Railways, Roads, Bridges and Geodesy within the Bucharest Construction Institute, under the guidance of prof. univ dr.ing. Nicolaie Oprescu NASA PI (Principal Investigator) code G – 27940.

Later, the concerns were supported and then coordinated by the Romanian Commission for Space Activities within the National Council for Science and Technology, a commission that published the Romanian Remote Sensing Bulletin for this purpose.

The Romanian remote sensing bulletin in which the list of researchers admitted to NASA as well as the list of titles and the summary of these topics were published.

The Field Laboratory of the Bucharest Construction Institute was built and put into use, located on the banks of the Dunavăț canal, equipped with calibration equipment, both for aerial photogrammetry and for satellite remote sensing. (see Fig. 6).

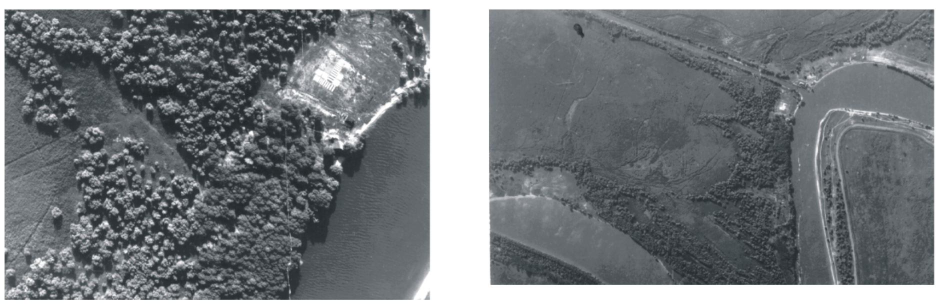


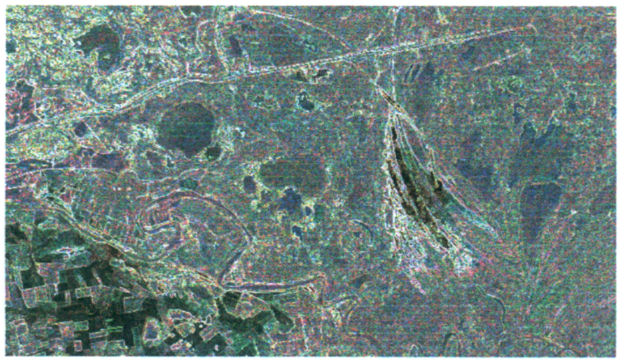
Fig. 6. The field remote sensing laboratory from Dunavăț (Danube Delta), On the left is the calibration gauge, and on the right is the overall view.

As part of the collaboration with this department, the author developed a package of LANDSAT digital data processing programs [Vais 1980], used in all research contracts that had as a partner the Photogrammetry Department of the Faculty.

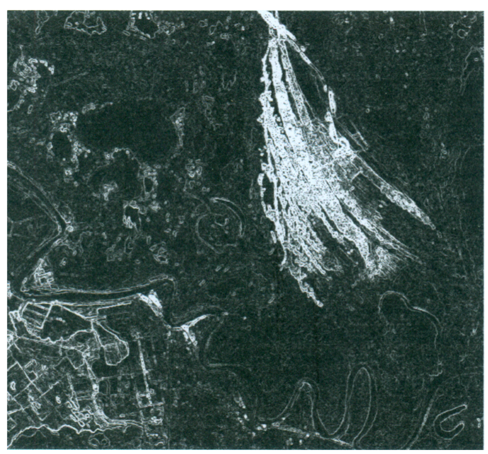
This program package, the result of using the accumulated mathematical knowledge (statistical processing) and the author's experience as a programmer, together with the rich experience in photogrammetry and remote sensing of Professor Nicolaie Oprescu, was made up of three components, namely:

- a component for transforming the LANDSAT recording format into one designed by us;
- a calculation component;
- a component for providing reports necessary for interpretation, obtained both from the initial data and from the transformed ones (eg one- and two-dimensional histograms, densitometry, thematic maps).

The calculation component was based on the Karhunen – Loeve matrix transform, which ensures the compression of a space with at least four dimensions, as in the case of LANDSAT – MSS recordings in which each pixel (pixel = picture element = image element) is characterized by four responses spectral, in a two-dimensional space at most. Also known as the principal component transform, it classifies the program package in the class of PCA (Principal Component Analysis) applications.



a.



b.

Fig. 7. LANDSAT - TM image from August 20, 1989, representing the beams from Caraorman and the field laboratory area from Dunavat. The works were done by the author, during the documentation internship at the Remote Sensing and GIS Laboratory of the Department of Geography, University of Nottingham, under the guidance of Prof. Paul M. Mather, in 1996. **a**) The histogram equalization and Sobel contour strengthening. **b.**) The principal component transformation (PCA).

At the same time, when calculating the equalized histogram, the numerical algorithm for the Fourier transform was used.

After 1991, the establishment of the Romanian Space Agency (R.O.S.A.), diversified the collaboration between the author and the aforementioned department, through research contracts [Vais 1993, Vais 1995, Vais 1996], also materialized through communications at various international scientific events [Oprescu, Vais and others 1995, 1996, 1997, 1997a, 1998].

On board of the LANDSAT -8 satellite, a new type of sensor, from a technological point of view, was installed, TIRS (Thermal InfraRed Sensor) in the thermal infrared field, for which, were also established procedures, for separation the LST (Land Surface Temperature) and thermal radiation from underground LSE (Land Surface Emissivity) which allows the development of applications regarding the geology of underground deposits (thermal waters,

					Spatial resolution		
Mission / Constellation	Louch Data	Unworkable from:	The orbit altitude	Period for revisit	Multi spectral	Panchro –matic	Spectral value on:
LANDSAT MSS - Multi Spectral Scanner							
LANDSAT - 1	23.07.1972	06.01.1978	919 km	18 days	79/56 m		8 bits
LANDSAT - 2	22.01.1975	25.02.1982	919 km	18 days	79/56 m		8 bits
LANDSAT - 3	05.03.1978	31.03.1983	919 km	18 days	79/56 m		8 bits
LANDSAT TM – Tematic Mapper							
LANDSAT - 4	16.07.1982	14.12.1993	705 km	16 days	30 m		8 bits
LANDSAT - 5	01.03.1984	05.06.2013	705 km	16 days	30 m		8 bits
LANDSAT ETM - Endhanced Tematic Mapper							
LANDSAT - 6	05.10.1993	05.10.1993	705 km	16 days	30 m	15 m	8 bits
LANDSAT - 7	15.04.1999	06.04.2022	705 km	16 days	30 m	15 m	8 bits
LANDSAT DATA CONTINUITY MISSION							
LANDSAT - 8	11.02.2013	In activity	705 km	16 days	30 m	15 m	12 bits
LANDSAT - 9	27.09.2021	In activity	705 km	16 days	30 m	15 m	14 bits

Tab. 1.

What are the development directions of this program?

- Collection and archiving of moderate-resolution infrared solar reflectance and thermal imaging data, enabling substantial cloud-free coverage of the global land mass for a continuous period of not less than 15 years beginning in 2026;
- Consider the existence of a constellation of satellites (with the potential to increase the frequency of passage)
- Tracking multiple bands with greater special attention (eg for vegetation, temperature or humidity)

- Improving spatial resolution

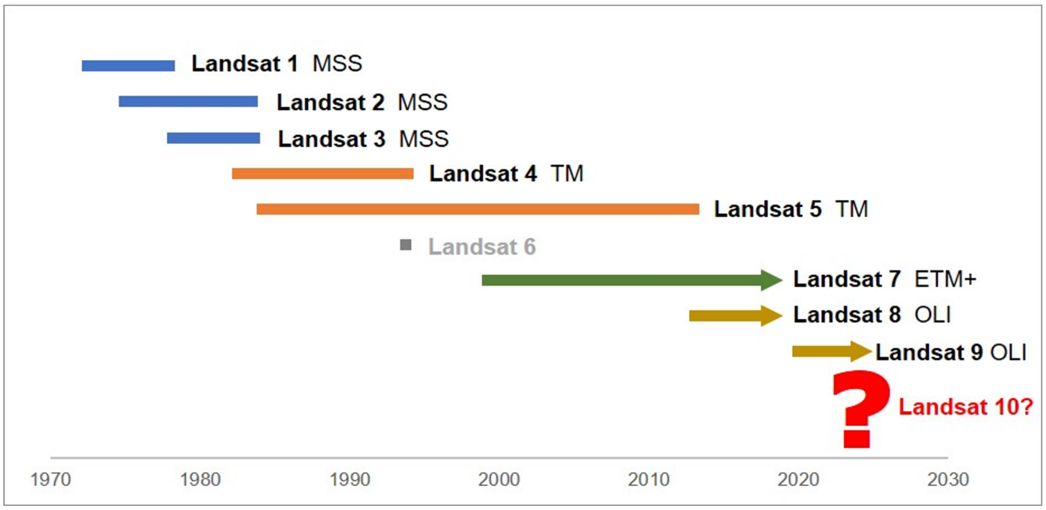


Fig. 8 The Satellites of LANDSAT program.

- Ensuring that newly acquired data, once integrated into the National Land Remote Sensing Satellite Data Archive (NSLRSDA), are sufficiently consistent with data from previous Landsat missions in terms of calibration, coverage characteristics, spectral and spatial characteristics, data quality data output and availability, to enable the detection and quantitative characterization of global land surface changes over multidecadal periods;

- Free and open access to a continuous stream of moderate-resolution data of quality and acquisition frequency consistent with over 50 years of Landsat observations, supporting the development and dissemination of a wide range of data products on a non-discriminatory and cost-free basis to users.

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