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Remote sensing, a tool to monitor and assess desertification

Remote sensing: both a science and a technology

Remote sensing is defined as "*all the knowledge and techniques used to determine the physical and biological characteristics of an object by measuring it without physical contact with it*"

From *Journal Officiel*, December 11th, 1980 (Bulletin of official announcements issued by the French Republic).

Study and monitoring of the environment and global changes


© NASA-MODIS

Within the scope of the combat against desertification, remote sensing allows to follow-up and monitor risk areas in the long term, to determine desertification factors, to support decision-makers in defining relevant measures of environmental management, and to assess their impacts.

Remote sensing is **a powerful tool to implement early warning systems, and to help policy- and decision-makers define relevant strategies** for sustainable development. Indeed, satellites allow to observe the Earth and cover at a reasonable cost very large expanses in a repeated, homogeneous and systematic way, which cannot be done on site. Today, a wide range of high, medium and low resolution satellites enable **to monitor our environment, to make comparisons in time and space, and to model how ecosystems work.**

A remote sensing system does not generate directly usable information. It is first and foremost a tool for data production. The art of remote sensing consists in converting physical measurements of surfaces into useful information. Such data must be analysed together with other data sources (field data, socio-economic data, etc…) in order to derive understandable information likely to be **integrated into information and decision support systems (Geographic Information Systems).**

Marc Bournof © IRD


Remote sensing to help combat desertification

Desertification factors are natural (climate) and human-induced (overgrazing, logging, unsuitable farming methods). In order to assess the degree or possible risks of desertification in a given area, such factors are associated with indicators that allow to **warn and help local or national authorities in undertaking relevant actions of environmental management.**

Two major desertification indicators are easily monitored thanks to space-based remote sensing: **(i) vegetation cover and (ii) composition changes in sand surfaces and wind transportation.** Remote sensing is used to estimate this type of desertification indicators through remotely sensed "derived variables" (soil moisture, biomass…).

Satellite-based monitoring should take into account the ecological features of the environments followed-up and rely on the knowledge of local processes. This is the necessary condition for being able to identify the status of an area and to interpret changes in surface states along time: environmental degradation, stability or restoration. Thanks to the increasing number of satellites and sensors, denser and more diverse information are collected from space.

The current challenge then consists in using them at best to obtain an accurate monitoring at the lowest cost, thus feeding early warning systems, which are the actual concern of the managers of the regions affected.

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How much do satellite images cost?
Prices vary a great deal, mainly according to the image category (archive or programmed) and characteristics (spatial and spectral resolution, pre-processing level), as well as to the different suppliers' policies.

In 2005, prices were ranging from 1,600 to 13,000 euros for high resolution images, while low resolution images are free. There are programmes aimed at supporting the scientific community: the ISIS programme (CNES) allows French researchers to buy Spot images at preferential rates (50 to 520 euros) through a compensatory scheme funded by CNES; the OASIS (European Commission) and TPM (ESA) programmes freely supply researchers with satellite data. Eligibility to these programmes is subject to conditions.

The cost of remote sensing is moderate considering its cost-effectiveness in relation to other data acquisition techniques. A well-considered use of remote sensing usually proves to be cost-effective.

Additional information:
- Pricelist of satellite images: www.eurimage.com
- ISIS Programme *(Incentive for the scientific use of spot images)*: medias.obs-mip.fr/isis/
- OASIS Programme *(Optimising Access to Spot Infrastructure for Science)*: medias.obs-mip.fr/oasis/
- TPM Programme *(ESA EO Third Party Missions Page)*: eopi.esa.int/esa/esa/

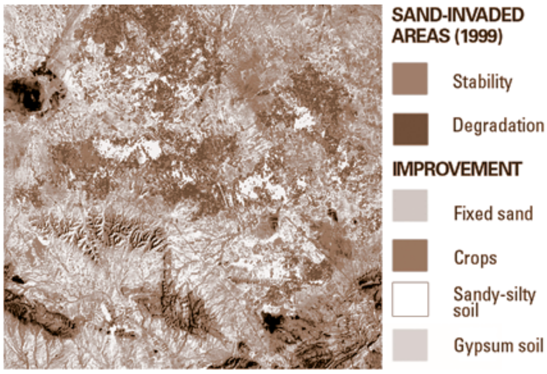
Example of application: Monitoring of a sandy steppe area

The Menzel Habib area in pre-Saharan Tunisia was affected by particularly severe desertification phenomena during the 80's, which were countered through a programme aimed at combating land degradation and sand invasion. Experiments of space-based monitoring and studies on long-term ecological indicators were led in this region. This site indeed belongs to the observatories of the ROSELT (Long-Term Ecological Monitoring Observatories Network) programme.

Observing remotely sensed image series makes it possible to design a sequence of the various surface states. Analyses should bear on long enough series (23 years in this area, i.e. 1976-1999) to derive trend syntheses. This monitoring concerned surface states (brightness and colour indices) rather than biomass, much too poor for its variations to be easily detectable. Each picture was classified according to a simple legend based on soil type and vegetation cover density. The percentage covered by each category was monitored over time so as to determine environmental evolution (stability, degradation or improvement).

The figure below illustrates a synthesis obtained by analysing trends observed in images classified over five dates (1989 to1999) and related to sand-invaded surfaces (unfixed moving sand, dunes, etc…). Sand-invaded areas actually decreased in favour of fixed sand areas and farming lands. The efforts undertaken in order to fix the moving sand that had invaded the region during the previous decade were successful. Space-based monitoring allowed to quantify this impact over large expanses, which was of course also observed locally on site.

Richard Escadafal © IRD



See original picture in the colour supplement of *Les dossiers thématiques du CSFD*, issue 2, page VI.

Remote sensing: a tool within everyone's reach?

Remote sensing is a reliable tool for data acquisition, but it is still quite expensive. In general, low resolution images (cheaper) are used for the regular (daily or weekly) monitoring of large surfaces. A few high resolution images (more expensive and acquired less frequently) may be used in more specific situations. Thus, when a seemingly unusual evolution appears in low resolution images (early warning), what is actually happening in such places can be observed more precisely with high resolution images and on-site assessments.

Between experts in remote sensing digital techniques and stakeholders of the combat against desertification, there is a "digital gap" that should be bridged up:

• by coupling remotely sensed data with *in situ* information
There is a long way between complex desertification processes, indicators that allow to monitor them, variables observable through remote sensing, and model representativity. Some difficulties are cleared up by integrating into models remotely sensed data and for instance, ground data, since some data cannot be acquired through remote sensing. Models should also be designed to be used in the long run.

• by improving international aid targeting
Investments, operating costs and expenses for experts' training must be allowed for. However, countries threatened by desertification are poor nations that can hardly finance such recurring costs, let alone keep specialised staff. Unfortunately, international aid usually concerns intellectual or material investments rather than recurrent operating costs, which might make investments fruitless (brain drain, obsolescent equipment);

• by enhancing the dissemination of remote sensing techniques to end-users
Comparatively simple products, such as warning bulletins, are available. It is essential that end-users should get them and be able to interpret them. Thanks to the development of digital communication techniques, their dissemination that used to be a problem a few years ago is being considerably improved. Nevertheless, the issue of training end-users in these new remote sensing technologies still remains pending.

It is essential to reduce these three types of gaps in a concerted way. If not, new knowledge might be generated without being applied, or the methods applied by relevant stakeholders might stagnate whereas technological advances would allow to forge ahead and ensure the sustainable development of the most vulnerable regions and populations of our planet.