

Potential and limitations of remote sensing for land management

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SUMMARY

Remote sensing has long been used for land use management due to the multiple possibilities offered by airborne or spaceborne imagery : land description and measurement (including in 3D), change detection, control of land use legality. Recent developments have led to a higher quality and an easier access to this information and to a lower cost per land surface unit. This could modify the actual potential and limitations of remote sensing for land management.

After a brief overview of remote sensing possibilities in the field of land management, the main recent technological improvements will be considered, mainly a higher spatial and temporal resolution, an improved absolute image location, and a facilitated free access to remote sensing imagery through the internet. Two recent evolutions allowed by these technological improvements will be particularly described and analysed : (1) new possibilities for virtual land property delimitation using orthorectified imagery, and (2) an increased involvement of all stakeholders due to the fact that remote sensing imagery is easily accessible to people with no technical education for communication or negotiation. For this reason, this technology can really be considered as a contribution to "bridging the gap between cultures".

RÉSUMÉ

La télédétection est utilisée depuis longtemps pour des applications foncières en raison des multiples possibilités offertes par l'imagerie aérienne ou spatiale : la description et la mesure du terrain (y compris en 3D), la détection de changements, le contrôle de la régularité de l'occupation. Les développements récents ont amélioré la fiabilité et l'accès à ces données, et ont contribué à réduire le coût par unité de surface de terrain. Ces évolutions pourraient modifier le potentiel et les limites de la télédétection pour les applications foncières.

Après un rapide survol des possibilités offertes par la télédétection dans le domaine foncier, les principales améliorations technologiques seront considérées, notamment une meilleure résolution spatiale et temporelle, une localisation absolue plus précise, et un accès facilité à l'imagerie par internet. Deux évolutions récentes permises par ces développements technologiques seront notamment décrites et analysées : (1) de nouvelles possibilités de délimitation virtuelle à partir d'images orthorectifiées, (2) une participation accrue de tous les acteurs permise par le fait que l'imagerie de télédétection est facilement accessible à des personnes sans qualification technique, pour la communication ou la négociation. Cette technologie peut donc être considérée comme une contribution au rapprochement des cultures.

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The use of aerial photographs and satellite images has long been considered separately, with very different approaches. Indeed, aerial photographs offer an intuitive interpretation of landscape organization, while satellite imagery is traditionally exploited through a quantitative approach. With the development of very high resolution imagery, both data sources offer the same possibilities and an overview of the potential and limitation of remote sensing for land management has become relevant.

1. TRADITIONAL USE FOR LAND MANAGEMENT

Remote sensing has become a traditional source of information for a variety of applications such as agriculture, archeology or urban planning, because it provides a better understanding of landscape organization. Among those applications, land management plays a central role, because the way society occupies available territories at a given historical time is described by the patterns written on the Earth surface by both nature and society, and this can typically be observed by remote sensing, provide that the right sensor can be selected to optimize scale (i.e. spatial resolution) and wavelength. Two famous meaningful patterns are illustrated below.



The USA-Mexico border in a SPOT image : two contrasting land management systems



The structure of deforestation in central Amazonia in a Landsat image

These patterns are typically governed by two kinds of influences :

- constraints generated by natural phenomena, often related with relief or hydrography, that put obstacles to urban growth or agricultural development, leading to specifically constrained patterns;
- constraints due to legal, cultural or economical specificities of the considered region and originating in the local social history.
- The way these two pattern systems overlap on the Earth surface can be observed in remote sensing images. However, the contribution of remote sensing for the analysis of such written patterns is not always limited to a visual interpretation and it can contribute to a variety of works related to land management:
 - planimetric and altimetric measurements as well as length and area computations, the accuracies being limited by spatial resolution and image distortions;
 - detection of historical land use patterns that are no longer visible on the ground (archeological aerial surveys);
 - comparison of declarations with the actual land use, and detection and characterization of irregular land use;
 - land value estimation;
 - design of visual supports for negotiation and public communication.



Ancient polder in French Guiana
(aerial photograph)

2. RECENT TECHNOLOGICAL IMPROVEMENTS

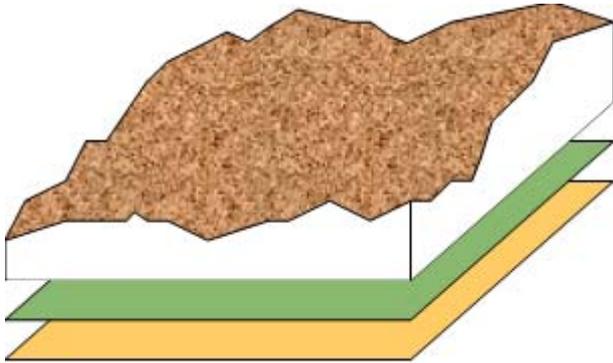
In the last decade, remote sensing benefited from new technological developments in the fields of optics, electronics, mechanics and image processing. Two main characteristics have been significantly improved, namely, spatial resolution and absolute location.

The improvement of spatial resolution has made spaceborne and airborne sensor products quite similar, with resolutions around one meter that probably contributed to the attractiveness of remote sensing for land management.

The improvement of absolute location has reduced the need for ground control points. This is an important advantage from an economical point of view.

3. OPERATIONAL IMPLEMENTATION OF REMOTE SENSING

The implementation of remote sensing for land management application has dramatically changed with the digital generation. In the 1990s the images were systematically scanned to be digitally processed. More recently, digital cameras appeared in the airborne remote sensing market. Finally geographical information systems became the new standard for land management projects.



However, a remote sensing image is a very particular layer in a GIS and its specificities have to be mentioned:

- a high spatial density, associated with important file sizes;
- multiple uses, since the image information is not thematically selected;
- an easy understanding for many users including with very reduced technical skill.

Since land management is often based on parcel identification, the landscapes have to be structured with parcels described by polygons, each polygon being modelled as an object with attributes and relationship with its neighbours. This is a typical limitation of GIS systems, since they are not suitable for fuzzy landscape organizations.

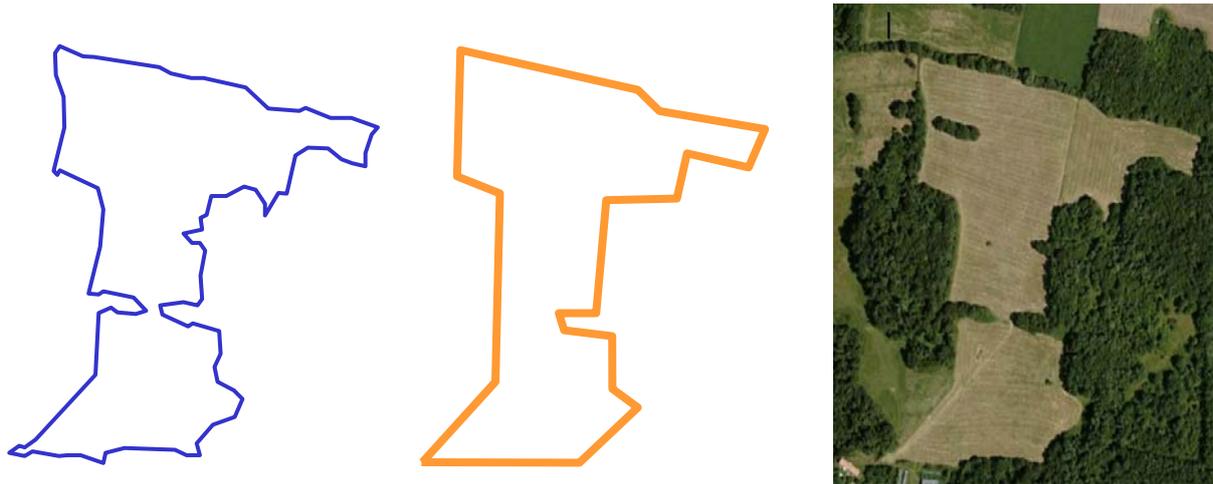
4. NEW POSSIBILITIES OFFERED BY REMOTE SENSING

In this context, remote sensing data can offer new possibilities for land management, and two possibilities are mentioned here.

4.1 Virtual delimitation

A remote sensing image will never replace a surveyor for land property delimitation. This is because the legal value of the image is not clear enough for many technical reasons, but also because legal limits do not always fit the visible limits as they can appear on the field. In spite of these limitations, however, remote sensing imagery can bring a support to the surveyor to overcome some intrinsic difficulties of land delimitation. For instance :

- when the legal limit is located in the middle of a wide vegetated edge or in the middle of a river, where the limit cannot be physically plotted on the ground : in these cases, the limit can be easily plotted in the image rather than on the ground, and the image can be used for measurements provided that it has been orthorectified ;
- when the limit is a curve, a polygon is not a suitable model; this is also the case when the limit is a very complex line that would require a very important number of ground marks : in this case, a limited number of marks can be considered to define the overall shape of the terrain parcel, and the satellite or aerial image can provide the detailed position with an accuracy limited by image resolution, as illustrated hereafter.



Left : actual limit. Center : limit as described by land marks. Right : limit as described by aerial image

4.2 Public communication

The availability of geographic information through internet access has greatly contributed to the awareness of citizens about environment and land management issues. An increasing number of surveyors or land administrations make use of remote sensing images to provide a context information in order to communicate with non expert partners or with a wider population about land management projects. This is because a remote sensing image is a “neutral” information in which each citizen can preserve his own culture and his own approach of environmental issues.

5. CONCLUSION

The intrinsic advantages of remote sensing data as well as the development of its access through its access make this technology very valuable for land management. Two examples have been indicated, namely, virtual delimitation as a help to conventional delimitation, and public communication.

BIOGRAPHICAL NOTES

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