REMOTE SENSING to support biodiversity

Extensive work has already shown the potential agronomic and ecological benefits of remote sensing.

Assessing and studying biodiversity first involves mapping land use using "off the shelf" maps, digitalised images, or maps produced from satellite images. The "TellAE" project explored this third option in the context of increasingly easily available data.

Agriculture brings a special type of biodiversity, encompassing all types of living organisms, animal and vegetable, from micro-organisms in the soil to large game. It can be harmful (bio-aggressors) or useful (organisms playing a role in soil fertility, or helping to regulate bio-aggressors). In order to clarify and quantify the interaction between biodiversity and agriculture, we must take into account the parcel layout as well as the characteristics of the landscape in which the farms operate. The aim may be to establish links between biodiversity and landscape as part of a study, or from an operational point of view, to qualify the biodiversity potential of a landscape, based on its characteristics. In that respect, agro-ecological infrastructures (AEI) are very important components of the landscape *(see insert).*

High potential

The simplest method is to mark by hand interesting components on aerial photographs, but this is only suitable for small areas. It is also possible to use ready-made maps (IGN or THEIA *(1)* in France), but those are not always as detailed as they would need to be. The last option is to produce one's own map based on satellite images.

« LANDSCAPE DESCRIPTORS: results depend on the image resolution. »

Extensive work has already shown the potential agronomic and ecological benefits of remote sensing. Indeed, satellite images are used to identify crops, predict yields, estimate biomass, etc. Remote sensing has advanced greatly over the last few years, thanks to open data, to a certain technological maturity and to public policy incentives. "Sentinel2" images, with a 10m resolution, are freely available to all kinds of players. Nowadays, technology allows remote sensing of hedges, boundaries, grassland, and, obviously, different crops. However, remote sensing of grass strips and more precise determination of grassland and hedges (botanical composition, vertical structure, etc.) are more problematic. The processing chain includes several stages. One or more satellite images of the area to be studied are of course required beforehand, and several images taken in the same year improve the classification process. Primary processing of the image(s) is necessary. This can be done by the provider. Next, the various components must be mapped. This means assigning to each pixel a land use category ("classification"). Landscape descriptors can then be calculated (the components' size, shape, surface, etc.). Finally, the interpretation of those descriptors helps to compare different landscapes objectively, and to study their impact, or that of specific components, on biological processes.

« INFORMATION PROCESSING: producing and interpreting maps requires various skills. »

The interpretation depends on the spatial resolution

The spatial resolution of the initial image must be adapted to the user's aims, and conditions the study results. A 10m resolution shows boundaries, copses and permanent pastures, but does not detect smaller hedges, or does not classify them properly. Opting for a 2.5m resolution eliminates those issues, but image processing is then more complex. A 50cm resolution is only used for very in-depth studies. Hedges then become fragmented components, which may make it difficult, for example, to calculate linear features.

The value of landscape descriptors is affected by the image resolution chosen. A greater amount of detail is detected at 2.5m, which involves a greater density of "patches" (solid colour) and a smaller average area than at 10m. The calculated proportion of hedges in the landscape is lower at 2.5m than at 10m: slimmer hedges are more easily detected at 2.5m, and those that are detected at 10m are disproportionally enlarged and their area is therefore overestimated. The aspect ratio is higher at 2.5m, showing curvier contours. Such differences could alter the assessment of the agro-ecological potential of a landscape. There is, for instance, a correlation between the number of bees present and a landscape's descriptors at 2.5m (link between the number of bees and the proportion of fallow ground and hedges in the landscape), whereas this is not the case with a 10m resolution. Therefore, the best level of precision with which to characterise a landscape should be determined based on which biological processes are being studied.

« SPATIAL RESOLUTION: the precision of the initial image must be adapted to the user's aims. »

Thanks to Tel-IAE, the user can ascertain the feasibility of various processing chains (images, tools, methods) and be informed of the set of skills and resources necessary for his or her project.

A resources centre

The aim of the Tel-IAE project (methods and tools to identify and characterise agro-ecological infrastructures through space-based remote sensing) was to bring together remote sensing specialists and users (managers, ecologists, agronomists) in order to match the needs of the latter with the data provided by remote sensors *(2)*.

The analysis of several case studies (national biodiversity observatories, automated mapping tool at farm level, implementation of agri-environmental measures, etc.) revealed very different expectations from one user to another (beginner or expert, observation scale, type of agro-ecological infrastructures). The Tel-IAE project led to the creation of a resources centre open to anyone needing to characterise agro-ecological infrastructures and to describe a landscape using remote sensing.

Accessible online at http://teledetection-iae.fr since 1st July 2016, the centre guides the user to resources matching his or her project, depending on its objective, the surface area in question and how often the required information is updated. It is a tool and provides the user with an introduction to this subject as well as resources to explore it further.

Agro-ecological infrastructures support ecologic processes that are considered as beneficial for biodiversity.

(1) Point of reference for remote sensing of continental areas (https://www.theia-land.fr)

(2) CASDAR project: technological research funded by the French ministry of Agriculture, Food and Forestry, which ran between 2013 and 2016, led by Terres Inovia, and involved ACTA, IDELE, ARVALIS, ACTA Informatique, UMR Dynafor, UMR CESBIO, UMR Tetis, MNHN, INRA SAD Paysage, El Purpan, and the Chambre Régionale d'Agriculture de Picardie.

« The interpretation of the descriptors helps with studying the impact of a landscape, or certain components of it, on biological processes. »

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The specific role of agro-ecological infrastructures

A landscape forms a habitat mosaic, the nature and spatial organisation of which have an impact on animal and plant populations. Among those habitats, agro-ecological infrastructures support ecologic processes that are considered as beneficial for biodiversity. They fulfil three main types of functions: habitat (zone suitable for reproduction, survival and/or feeding of the fauna), connectivity (shift and connection between different environments) and protection (to limit erosion and the flow of polluting substances, ensuring a wind breaking effect). Agro-ecological infrastructures (AEI) can be divided into categories (wooded areas, orchard pastures, boundaries, grass areas, cover crops and various other components such as wetlands, low walls, tree stumps, etc.). Some annual or permanent crops can be added to the list, depending on their function.