Environmental observatory of sensitive habitats, using Pleiades HR data, contributing to biodiversity protection: case of the Common Hamster in Alsace, France

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Abstract. Within the context of insuring the long-term viability of the common hamster populations in France, the French Ministry of Environment turns to Earth Observation (EO) satellite imagery, calling on SERTIT, a valorization service specialized in the production of geoinformation from remote sensing data, to analyze and monitor the pressures exerted on the rodent. Landcover analysis and habitat characterization are performed using very high resolution (VHR) satellite imagery acquired at the end of hamster's hibernation period, highlighting both favorable areas and threats to the rodent. Through the spatial analysis of this landcover mapping, favorable crop density indicators are derived providing an overview of biotopes connectivity. This work, firstly based on SPOT 5 imagery, today relies on Pleiades constellation offering better performances, both thematically and geometrically, thanks to its submetric spatial resolution, which is essential within small scale biotopes detailed analysis. VHR Pleiades data allow a more precise detection of landscape features; smaller elements are identified leading to more detail in landcover mapping and connectivity analyses. These annual EO based analyses, complementing slow and punctual field surveys, are particularly useful to rapidly assess the quality of hamsters' biotope, implement new measures to improve their habitat in critical areas and evaluate the effectiveness of the existing environmental biodiversity protection actions. This case emphasizes the benefits of Earth Observation data in characterizing biotopes, part of the green and blue landscape, within the context of biodiversity conservation. EO data being well adapted to multi-scale and multi-temporal analyses, this type of work is applicable to the whole green and blue landscape network, and then to other species.

Keywords. Biodiversity, Habitat, Biotope, Pleiades, Ecosystems, Green and blue landscape, Environmental management, Agriculture, VHR.

1. Introduction

For a long time considered as a pest, the common hamster (Cricetus cricetus), present in France only on the Alsace Plain, is today a critically endangered but protected species. France, being sued for non-assistance to an endangered species by the European Commission for years, has had to rapidly react through species conservation National Action Plans. Within this context of insuring the long-term viability of the hamster populations, the French Ministry of Environment annually orders mapping studies of the hamster's environment in Alsace using satellite imagery to analyze and monitor its habitat and the pressures exerted on the rodent.

SERTIT, a service of the University of Strasbourg, with more than 25 years experience in remote sensing and geo-information production from Earth Observation (EO) data, is in charge of this operational work in order to rapidly assess the effectiveness of the existing environmental biodiversity protection measures.

2. Method

The landcover of the whole area populated by common hamsters in Alsace is mapped from automatic classifications of high and very high resolution satellite imagery, and then validated via photo-interpretation and field observations within a radius of 600 meters around hamster burrows; this area corresponds to the roaming territory of the rodent. This work relied on a preliminary analysis of the spectral and textural characteristics of the data, indicating the thematic precision of the landcover classification, and in particular of the possibilities and limits in differentiating crop-types. According to the spatial resolution of the satellite data, the classification is more or less accurate both thematically and geometrically; submetric data being preferred in this context of small scale biotopes. Thresholds in spectral bands plus vegetation (NDVI), brightness and shadow indexes are the basis of this landcover mapping.

This early spring mapping highlights hamster-friendly crops (winter cereals and feed crops – alfalfa, clover), bare soils (maize and other spring crops), artificial features (urban areas and large transport infrastructure), and other features of the green and blue landscape (forest, prairies, vineyards, water bodies), and is meticulously carried out around hamster burrows every year, giving an accurate idea of the situation at the end of the rodent's hibernation period (end of March / beginning of April). This period appears as a key moment for hamster survival, as spring crops, which constitute a large majority of cropland, are not yet planted or are still underground, they do not provide protection against predators or food.

The method was established using SPOT 5 (4 spectral bands, 10m spatial resolution) and simulated Pleiades data (Worldview-2, 50cm) a few years ago evaluating the potential of these EO datasets in this environmental observatory and biodiversity conservation application. This feasibility study revealed the value of high and especially very high resolution satellite data for this topic, and the monitoring of hamsters' environments is today an operational activity with Pleiades submetric data (4 bands, 70cm spatial resolution, rescaled to 50cm), the method being transferable to other sensors.

3. Results

The work based on high resolution SPOT 5 data provides good results. The radiometric characteristics and spatial resolution of the SPOT 5 sensor enable a differentiation of landcover features and mapping of the hamster's environments; moreover, hamster-friendly crops can be detected, and the distinction between winter cereals and feed crops is possible. The validation work using field observations confirms the accuracy of EO based results. But the Pleiades constellation offers better performance, both thematically and geometrically, thanks to its submetric spatial resolution, and brings up to 20% increased precision over the SPOT 5 classification. Very high resolution (VHR) optical data enable a more precise detection of landscape features [1].

Firstly, the texture of these data enables a better differentiation of favorable crops: cereals have a smoother appearance than feed crops; the same can be observed for favorable crops and prairies, which have similar spectral signatures but different textures (and not the same interest for the rodent). Moreover, Pleiades HR data improve parcels outlines delimitation: neighboring narrow parcels can be distinguished and smaller elements than those visible on SPOT 5 images can be identified, leading to greater detail in landcover mapping and connectivity analyses. The smallest and narrowest being as important as the largest parcels of favorable crops for hamster conservation, the

Pléiades system's spatial resolution constitutes a major advantage for the mapping of the rodent's environment.

Furthermore, crops at an early stage of development are also detected through spectral and textural analyses; this constitutes a huge advantage of Pleiades system compared to high resolution sensors. In addition to that, the texture of submetric images leads to the detection of agricultural work such as furrows in fields, harvested crops and plastic covering, whereas SPOT 5-like data provide a coarser detection of parcels. Therefore, the details provided by Pléiades HR image texture represent a great improvement in environmental mapping; high resolution SPOT 5 data are not fully adapted to the hamster's habitat scale because some key parcels are not visible. Figure 1 gives an idea of the details provided by SPOT 5 and Pleiades data, over hamster's habitat in Alsace. Statistical analyses comparing the classifications based on Pleiades and SPOT data also highlight the benefits of VHR data. SPOT data generates more confusion between the vegetation classes (hamster's friendly crops and other green features) than Pleiades ones.

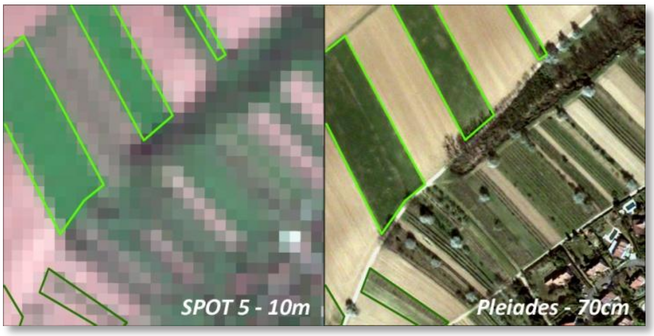

Figure 1. Comparison of high and very high resolutions over a hamster' favorable area[1]

The mapping of the common hamster's environment clearly underlines some of the threats to the rodent in the area: the fragmentation of their biotope by road infrastructure, isolating populations (leading to problems for meeting and reproduction); the extent in early spring of bare soils (compared to favorable crops), which are spring crops that do not provide food and cover for a long time after the end of hibernation; the proximity of urban areas, that continuously eat into their natural environment. This detailed geographic analysis highlights the extent of rodent's adverse environment, and of human pressures on the hamster populations. Figure 2 presents the landcover mapping in a 600m radius area around burrows in spring 2012, and some of the threats to the rodent in its historical core area, on a Pleiades HR image acquired the 1st of April 2012.

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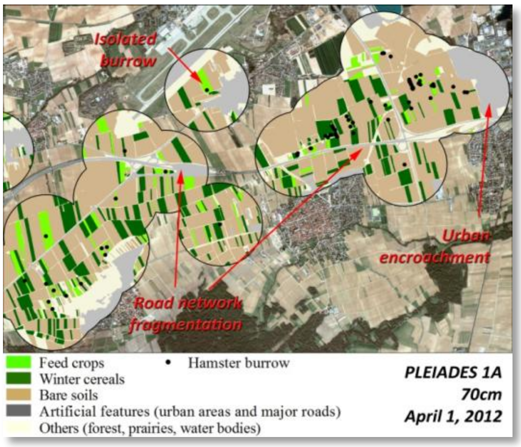

Figure 2. Example of landcover mapping around hamster burrows and human pressures on the rodent

This mapping is particularly useful to decision makers: it contributes to measures that financially support favorable crops in sensitive areas, move endangered individuals to more favorable areas, and insert breeding hamsters into winter crops parcels. The annual EO monitoring of hamster biotopes is also valued as it provides knowledge on whether Ministry objectives concerning the proportion of favorable crops are reached or not. For example, an important decrease of winter cereals has been noticed in 2012 compared to the past years, but also a decrease of artificial elements which means that hamsters move away from urban areas. The annual monitoring of the hamster's environment using satellite imagery also emphasizes the positive effects of the species conservation actions: some years, we can notice a highest proportion of favorable crops in burrow environs than the objectives, as well as a decrease of bare soils.

However, the survival and reproduction of the common hamster do not only depend on the quantity of winter crops, but also on a fairly dense spatial distribution. A good proportion of favorable crops is inefficient if not well distributed. A good distribution of winter crops near every burrow is essential to protect and feed hamsters as well as to provide corridors to facilitate hamsters coming together and hence reproducing. The analysis of favorable crop spatial distribution is therefore annually carried-out through density indicators, which highlight favorable and unfavorable areas, as illustrated in Figure 3.

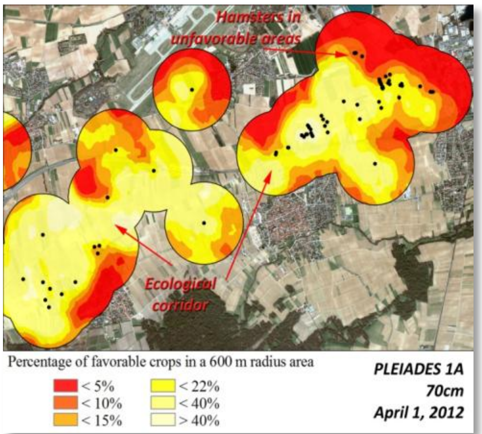

Figure 3. Example of winter crop density in the hamster's historical core area in Alsace

They also offer a vision of possible networks and their quality or otherwise, indicating if the biotopes are connected or not, and then reveal ecological corridors at a local scale. However, these indicators do not take into account major roads which can also constitute connection barriers (if there are no hamster pipelines).

The annual monitoring of winter crop densities, which underlines major changes in favorable area distribution from year to year, is necessary in order to have an idea of network evolution, and gives an overview concerning the efficiency of hamster protection policies and actions. To measure the conservation rate of favorable areas year-on-year, another indicator monitoring ecological habitat continuity has been developed. Figure 4 presents this indicator over the hamster's historical core area: dark blue areas represent continuous favorable habitat between 2011 and 2012 whereas other colors correspond to new or disappeared favorable areas. These indicators are derived from landcover classifications; therefore, Pleiades HR data providing more precise landcover mapping, density and continuity indicators are also more accurate than with SPOT and high resolution sensors in general.

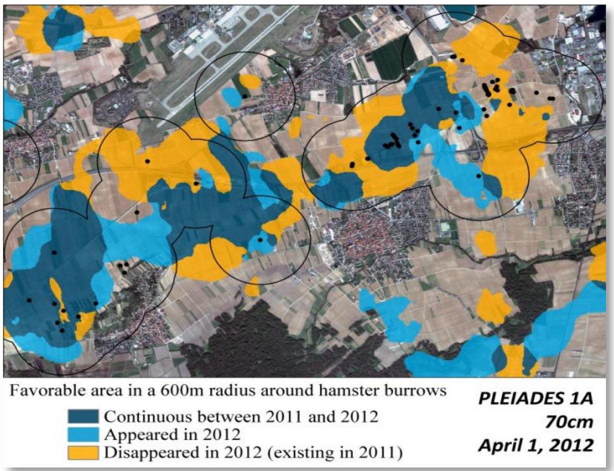

Figure 4. Example of ecological continuity mapping in the hamster's historical core area in Alsace

4. Conclusions

This work emphasizes the benefits of EO imagery, especially that of VHR data, in characterizing biotopes within the context of species conservation. EO imagery being well adapted to multi-scale and multi-temporal analyses, this type of work is applicable to the whole green and blue landscape network, and then to other species. Today, the use of satellite data in the mapping and monitoring of the common hamster's environment is an operational application in Alsace, and it would be particularly interesting to reproduce this work over other regions in the world as well as for other species, and to apply it to the whole green infrastructure at different work scales.

The user's continued interest confirms the usefulness of satellite data in biodiversity conservation. SPOT 5 high resolution data, which constitute the basis of this study, provide good results in hamster habitat characterization. However, submetric sensors such as Pléiades HR bring important improvements, both thematically and geometrically, to the analysis of hamster's environment and more generally to small-scale biotopes. The French Ministry of Environment being particularly convinced of the results provided by Pleiades HR data, this analysis is now a routine methodology listed in the current action plan for the species.

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