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OBJECT BASED “DAYAS “ CLASSIFICATION USING SENTINEL A-2 SATELLITE IMAGERY CASE STUDY CITY OF BENSLIMANE

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ABSTRACT:

The management of “DAYAS “ is a major issue in the preservation and maintain of biodiversity and environmental balance, especially in a context where this fragile ecosystems face many degradation factors.
The extraction of Dayas is a key component in the management process of this type of wetlands, and has been the subject of many researches related to remote sensing.
The methods and instrumentation for optical remote sensing are used to improve the mapping of Dayas, based on the radiometric characteristics of local hydrosystems.
The present paper studies the inputs of different methods for the delimitation and extraction of Dayas in the realm of Benslimane city, using Sentinel A-2 imagery for the mapping.
The methodology for the application of the pixel-based and the object-oriented approaches requires many steps, starting from an image pre-processing with Sentinel-2 calibration, the calculation of NDWI index, to proceed to the extraction of Dayas from the very high resolution image segmentation, then the application of the object-oriented classification to validate the results.
The cartographic results demonstrate the input of the applied methodology in the Dayas extraction in different situations and timing (winter/summer), and allow to measure the cartographic accuracy for each approach, finding 65% of accuracy for the pixel-based approach with Kappa index =0.40 versus 75% of accuracy for the object-oriented approach with Kappa index = 0.72.
The results achieved inform and orient about optimisation measures and regulations of the Kappa index to improve the Dayas extraction and mapping.

1. INTRODUCTION

The temporary wetlands of the Benslimane region (locally called dayas), constitute a national wealth and a natural heritage of great importance, these environments are characterized by the alternation of flooded and exondees phases. The dayas come in the form of lakes, lagoons, ponds, ponds, temporary streams, and flood plains but also artificialized environments such as rice fields or salt marshes. They also represent ecosystems very diverse in size, shape, depth, location, uses and ecological situations.

For many years, dayas have had strong ecological interests because of their biological, hydrological and biogeochemical functionalities (SSC / IUCN, 2004, Barnaud and Fustec, 2007, Mignot, 2005). These environments are thus at the heart of management issues for local communities and environmental management organizations. The first devices for the preservation of these environments had for objective their patrimonialization (ZNIEFF, NATURA 2000, etc.

Remote sensing is an inventory method that demonstrates potential and efficiency for the detection and characterization of wetlands (Hubert-Moy et al., 2003). Satellite or airborne images, thanks to their spatial, spectral and / or temporal resolution, make it possible to treat vast territories more quickly by the exhaustive survey of the terrain. However, at the interface between terrestrial and aquatic environments, which are often of limited size, these ecosystems remain difficult to comprehensively identify (Girard and Girard, 1999). Dayas are well representative of this problem. They are of great ecological interest (floristic and faunistic wealth) but are potentially difficult to detect (small size, drought, etc.). The emergence of Very High Resolution Spatial data with high repeatability, which will be produced by Pléiades or Venµs space missions, offers new perspectives. The objective of this article is to determine if the Very High Resolution Spatial images can constitute a support adapted to the cartography of the dayas of the city of Benslimane, in particular compared to data with High Spatial Resolution which present a resolution richer spectral.

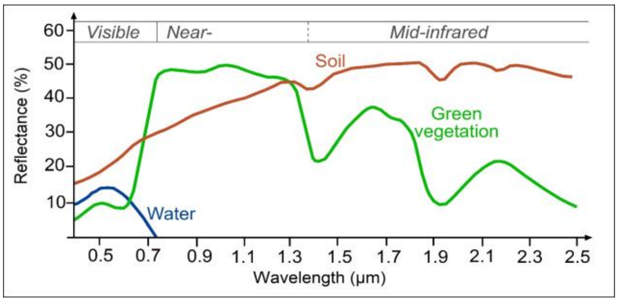
Depending on the nature and intrinsic characteristics of the objects and surfaces, the incident radiation will interact with the target according to one or other of the properties mentioned above, or generally according to a combination of these properties. Each surface has a spectral signature - quantity of energy emitted or reflected as a function of the wavelength - which is specific to it and which will allow its identification on the satellite images. The figure below shows the spectral signature of the main natural surfaces.

Water has a very low reflectance in all wavelengths, but it absorbs a little less the shorter waves, hence its blue color. Its spectral signature depends both on the molecules that make it up, but also on dissolved or suspended elements in the water column, such as phyto-planktonic organisms, sediments or yellow substances. When the surface layer contains high concentrations of phytoplankton, we observe an increase in the reflectance in the wavelengths of the green and the water therefore seems greener (Figure 1). The more turbid the water, the more it contains sedimentary materials, the more its reflectance increases in all wavelengths and especially for the longest waves - red.

Figure 1. Reflectance of water, bare soil and vegetation in different wavelengths, source: SEOS Project

2. IDENTIFICATION OF DAYAS BY REMOTE SENSING

Several studies had dealt with the issue of mapping dayas. The literature offers different studies, using different image products with treatment methods tailored to each case study. The common point of these studies is the search for a classification optimal for all types of object characterized by the existence of water.The extraction of dayas has become a very important part of remote sensing since water monitoring plays a very important



role in the integrated management of water resources. From satellite images, extraction has been a problem for more than two decades. Indeed, several clues have been developed over the years to try to eliminate misleading information, such as topographic shadows, cloud shadows, built-up areas, snow and ice. The reason for the above misleading information comes from the difficulty of distinguishing water from other surfaces with a low albedo. Although the indices have been improved over the years, there is still a need for more effort in extracting water bodies to effectively maintain water resources (Li et al., 2014).

Extraction of water from satellite images has since been conducted in many areas of research. As of 1995, the first standardized difference water index (NDWI) (Gao, 1995) was developed. To date, many other indices and methods have been developed (Ding, 2009, Feyisa et al., 2014, Lacaux, Tourre et al., 2007, McFeeters, 1996, Meng et al., 2013, Pereira-Cardenal et al. 2011, Rogers & Kearney, 2004, Xiao et al., 2010, Xu, 2006, Yan et al., 2007, Yuanzheng et al., 2016).

However, they still face the same problems. In a recent study, a method that uses NDWI (McFeeters, 1996) and the temperature of the Earth's surface has been developed, improving results by over 80% (Kaplan & Avdan, 2016). In addition, the pixel classification can be used to classify areas occupied by water. Both types of pixel-based classifications are unsupervised and supervised classifications.

- In the unsupervised classification, the pixels are grouped according to the reflectance properties of the pixels and the created groups are called "clusters". The number of clusters must be identified by the user. The two main grouping algorithms are K-means and ISODATA.

- Supervised classification is done by selecting representative samples for each land cover class in the image and land cover classification is based on the user-defined spectral signatures. The created samples are called "regions of interest".

The classification by the object-oriented approach therefore makes it possible to use multi-resolution segmentation and classification. The object-oriented approach has been used in recent years, and frequently applied in different types of zoning (Câmara et al., 1996, Flanders et al., 2003, Kettig et al., 1976, Ryherd et al., 1996; Strahler et al., 1986) as in vegetation (Yu et al., 2006), forest cover (Heyman et al., 2003) and extraction of water bodies (He et al., 2016). Publication of articles related to the object-oriented approach has increased considerably since 1995 (Blaschke, 2010). As the spatial resolution of imagery is an important factor in the choice of image classification techniques (Blaschke, 2010), the object-oriented approach is more accurate and efficient compared to the traditional pixel-based classification.

Most studies for object-based classification use high resolution images, such as IKONOS, QuickBird (He et al., 2016), SPOT (Polychronaki et al., 2012), or images of an aerial vehicle without pilot (Comert et al., 2016).

3. ANALYSIS OF IMAGE BY CLASSIFICATION ORIENTED OBJECT

It has been widely mentioned in the literature that pixel classification procedures often lead to erroneous land-use classifications, leading to the "salt and pepper" effect, due to a relatively large number of isolated pixels. misclassified. It has been proposed to use the "object-oriented" classification approach, which is based on the characteristics of the segments or regions resulting from the input images. This approach has traditionally been applied to high resolution images, where image segments have been calculated primarily based on spectral similarities between neighboring pixels. A single class, determined by LandSat, Sentinel-2 and Geoeye classification, was assigned to each segment, eliminating the salt and pepper effect in the classification.

The object-oriented approach not only exploits spectral information, but also introduces into textural and contextual geometric information (Benz et al., 2004)

The use of segments as processing units instead of pixels has several advantages. They concentrate the analysis of texture and significant statistics, including the topological characteristics and the nature of the objects of the image that is closer to real objects which allows a more reliable classification (Benz et al., 2004).

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The first image processing software dedicated entirely to object-oriented analysis "eCognition" was produced by Definiens and allows a flexible integration of the information extracted from the imagery into a geographical information system.
Object-based analysis involves three essential steps, segmentation, characterization, and classification.

4. METHODOLOGY ADOPTED AND DATA USED

4.1 Data used

The Sentinel-2 satellite is part of the Earth Observation mission developed by the European Space Agency. It was launched on June 23, 2015 (Nowakowski, 2015).
The satellite carries a single multispectral instrument (MSI) with 13 spectral channels, which use the push-broom concept. The resolution varies between 10 and 60 m. The visible (R, G, B) and near infrared (NIR) bands with 10m resolution, the vegetal red edge bands (5,6 and 7) and the short wave infrared bands (SWIR) at 20m resolution, and the rest of the bands have a resolution of 60 m (Agancy, 2015). (Table 1).

Sentinel-2 bands	Central wavelength (µm)	Resolution (m)
Band 1 – Coastal aerosol	0.443	60
Band 2 – Blue	0.49	10
Band 3 – Green	0.56	10
Band 4 – Red	0.665	10
Band 5 – Vegetation red edge	0.705	20
Band 6 – Vegetation red edge	0.74	20
Band 7 – Vegetation red edge	0.783	20
Band 8 – NIR	0.842	10
Band 8A – Vegetation red edge	0.865	20
Band 9 – Water vapour	0.945	60
Band 10 – SWIR – Cirrius	1.375	60
Band 11 – SWIR	1.61	20
Band 12 – SWIR	2.19	20

Table 1. Characteristics of Sentinel 2 Strips

The images used dated April 17, 2018. The Sentinel A2 images cover a scene with a floor width of 290 km.
The images of this period have less noise due to clouds. As well as dayas are filled by water, which facilitates the separation of dayas from other targets such as built-up areas and wet soils.

4.2 Méthodology

To evaluate the contribution of Very High Resolution Spatial images for the mapping of dayas, several classification methods are evaluated on a site located in the city of Benslimane.
In order to achieve the goal of the work, several treatments were carried out to map the dayas in the study area mentioned above. The process followed is based on the following steps:

- Radiometric and atmospheric correction of Sentinel A2 satellite images: The purpose of preprocessing Sentinel A2 images is to make images coherent and consistent. The preparation of the series of images includes several corrections: radiometric and atmospheric correction, and gap filling.

- Gap filling Sentinel A2 images: Several solutions and algorithms were then suggested to reconstruct the data and fill in the missing data or gap filling of the images (Chen et al., 2011). The solutions proposed include simple methods of bilinear or cubic interpolation from surrounding pixels or geostatistical methods.
- NDWI calculation for images: The NDWI can be calculated in such a way as to focus this time on the water surfaces and not on the moisture of the plants and the soil, this makes it possible to estimate the evolution of the water surfaces by comparing a series satellite images at different time periods. His equation is:
NDWI = (Green-band – Near-infrared) / (Green-band + Near-infrared)
- Segmentation of the Very High Resolution Spatial image and extraction of the dayas, this method consists in dividing the image into homogeneous regions, which can be aggregated to generate significant image object primitives, with a homogeneous color or spectral behavior, a texture and a similar shape, so to bring out the real objects of the field. Objects are created by region growth, that is, by fusing adjacent pixels. A parameter of scale or criterion of heterogeneity is fixed by the user, to stop the process: it integrates the color and the form of the objects.
- Pixel-based classification of the Sentinel A2 image,
- Object-oriented classification of the Sentinel A2 image,
- Overlay of the dayas resulting from the classification on the limit of the development plan,
- Validation and mapping of dayas.

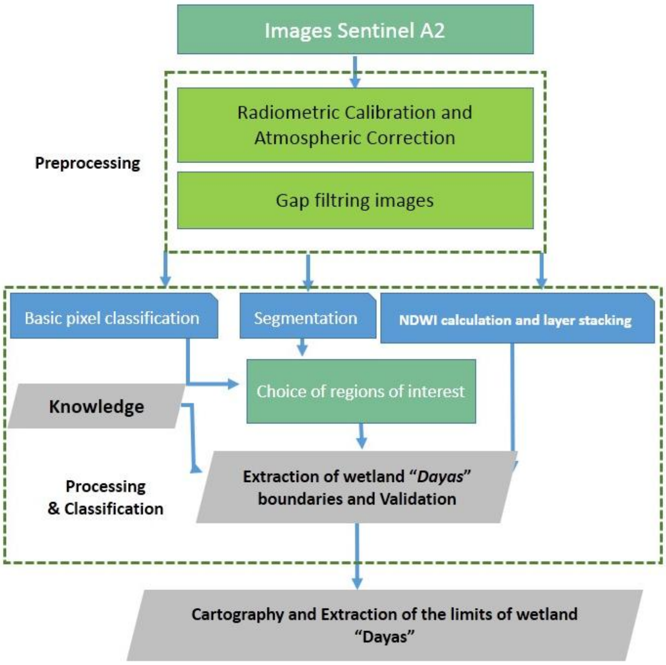


Figure 2. General methodology of work

The pretreatment of the series of images is intended to make the images consistent and uniform. The preparation of the series of images includes several corrections: The radiometric and atmospheric correction, and the gap filling, the geometric

correction was not carried out since all the images used are at level L1T ortho-rectified.
At the object-oriented classification level, we performed several tests to find the optimal parameterization giving a segmentation that best represents the boundaries of the parcels. Several parameters have been adjusted, the choice of a parameter is passed by the setting of the other parameters. The first targeted parameter is the choice of the segmentation scale. The choice of the form / color criterion comes second and then the compactness / smoothness criterion. All spectral information was included taking into consideration all spectral bands with a weight of 1 for each of the red, green, blue bands and a weight of 2 for the Near Infrared PIR.
The segmentation step is important and influences the result of the classification which differs according to the chosen segmentation algorithm. The following table summarizes the essential parameters of the segmentation under the "Ecognition" software.

Parameter	Value
Algorithme de segmentation	Multiresoltion segmentation
Echelle ou scale parameter	30
Poids des bandes (R,G,B,PIR)	1,1,1,3
Shape	0.65
Compactness	0.92

Table 2. Sentinel 2 image segmentation settings

4.3 Study area

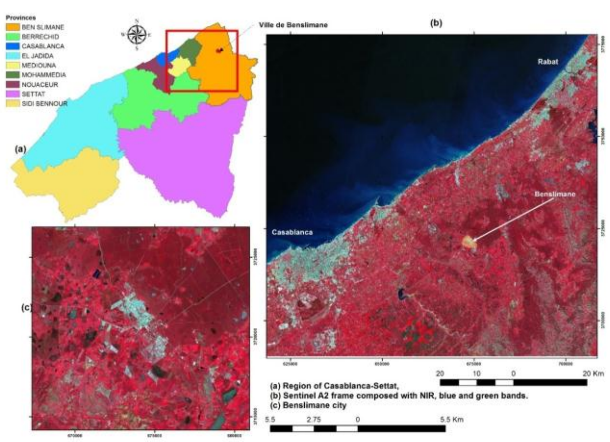


Figure 3. Location of the study area

The study was conducted on the territory of the city of Benslimane, capital of a province and a hinterland with an agricultural vocation, limited to the West and the north by the municipality of Ain Tizgha, to the south by the municipality Ziaida and to the east by the municipality of Oulad Yahya Louta.
The extreme altitudes range from 175 in the north-west to about 390 m in the south-east. the city of Benslimane covers an area of 76 km2, its polar coordinates are 33 ° 36N latitude and 7 ° 06W longitude, its average Lambert coordinates are: x = 342000, y = 336000
The population of the city of Benslimane is about 58000 Hah (RGPH 2014).

4.3.1 Climate

Benslimane is characterized by two types of climate that differ significantly from one region to another:
- A temperate and humid climate as we approach the coastal regions.
- A dry climate with alternating cold and heat, continental type when approaching the mountainous areas and to the south of the Province.

4.3.2 Temperature:

The average annual temperatures of Benslimane are of the order of 23.7 ° C for maxima and 10.3 ° C for minima. There are significant variations when one moves away from the Atlantic coast. The coastal zone has an average annual temperature of 17.5 ° C with maxima not exceeding 32 ° C. The low plateaus of the interior show quite strong thermal amplitudes but without sudden variations. On these plateaus, the average annual temperatures are of the order of 18.5 ° C with maxima of 40 ° C.

4.3.3 Rainfall:

The average annual precipitation recorded in the province is of the order of 350 mm.
For the Feddan Taba and Malleh Dam pluviometric stations, the average annual rainfall measured for the period 1977-2008 is about 310 mm.
The average monthly rainfall distribution shows the existence of two distinct rainy seasons:
- a wet season, from October to April, during which almost all the rainy episodes occurred (86 to 92% of the annual rainfall);
- a dry season, from May to Septembre , with only 8 to 14% of the annual rainfall.

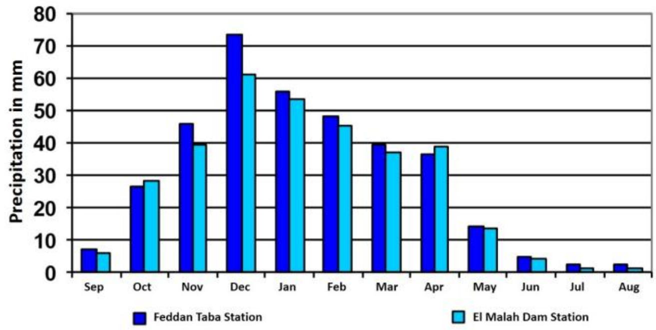


Figure 4. Distribution of average monthly rainfall at El Mellah dam and Feddan Taba hydrological station

The following figure shows the chronology of annual rainfall. It marks a periodic evolution of about 38 years with a maximum of 783mm recorded in 2010.

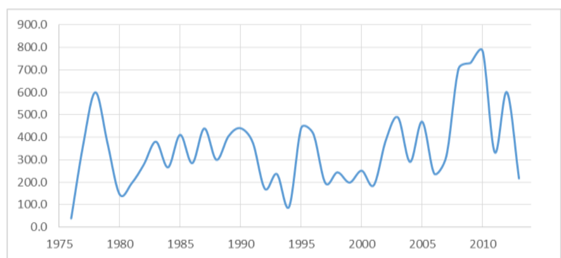


Figure 5. Distribution of average annual rainfall at the Feddan Taba hydrological station

5. RESULTS AND DISCUSSION

The figures show the results of water extraction according to the approaches of pixel-based classification (unsupervised and supervised) and object-oriented classification and NDWI analysis.
Since the NDWI method was developed for Landsat satellite imagery and the threshold is suggested at zero (McFeeters, 1996), for Sentinel satellite images, we suggest that the

threshold be greater than zero (in this case, 0.3) (Gordana and Ugur, 2017). The results of the NDWI analysis show that the method successfully extracted zones considered as dayas in the city of Benslimane. However, the NDWI analysis failed to emerge from other existing small dayas zones. Which leads us to conclude that the index NDWI allows to extract only dayas with important surfaces higher than 100m2.

The following figure shows the dayas extraction by the 1996 standardized McFeeters water index NDWI approach.

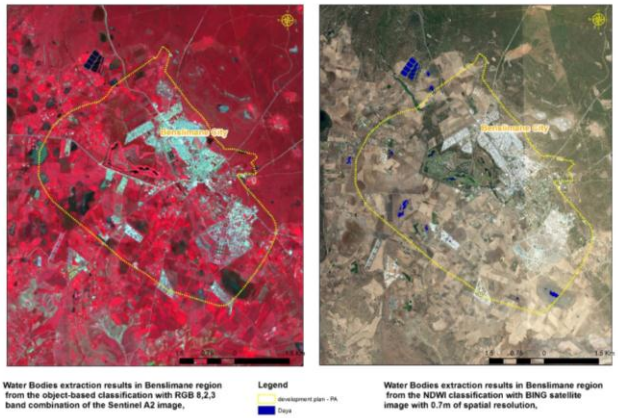


Figure 5. Identification of dayas by the NDWI index

In the same area of study, the pixel-based classification has identified several territorial components in urban areas, including dayas, shadows of existing buildings, dark objects to the effect of topography ... etc. not necessarily a water component thus requiring a correction. This problem is spread in the forest area to the north and north-east of the city, most information related to dayas was well ranked (Gordana and Ugur, 2017).

It was observed that in the unsupervised classification, more than the number of classes is high, the more water objects were clearly identify other areas. In the unsupervised classification, unexpectedly, the accuracy was almost the same as that of the supervised classification. In our case the unsupervised classification gives good results especially for golf dayas as well as dayas "Dayat Berwag" and "Dayet al Kahfa".

The following figure illustrates the results of the object-oriented classification of the Sentinel A2 image.

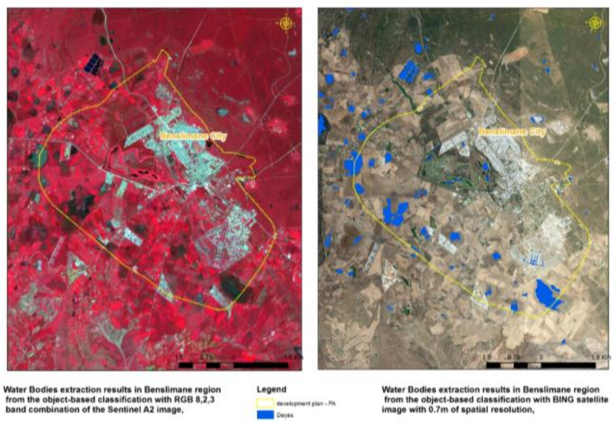


Figure 6. Extraction of dayas by the object-oriented approach

As for the object-oriented classification, it gave better results in precision analysis and showed no fuzzy or inaccurate information that could distort the result of the classification. Also note that some dayas of very small sizes smaller than 100m2 have not been identified either because of the high thresholds of the basic parameters of this type of classification (geometry, color, brightness ... etc) and conditions chosen (threshold of the spectral band ratios) established at the last step of the algorithm developed under Trimble Ecognition 9.3.

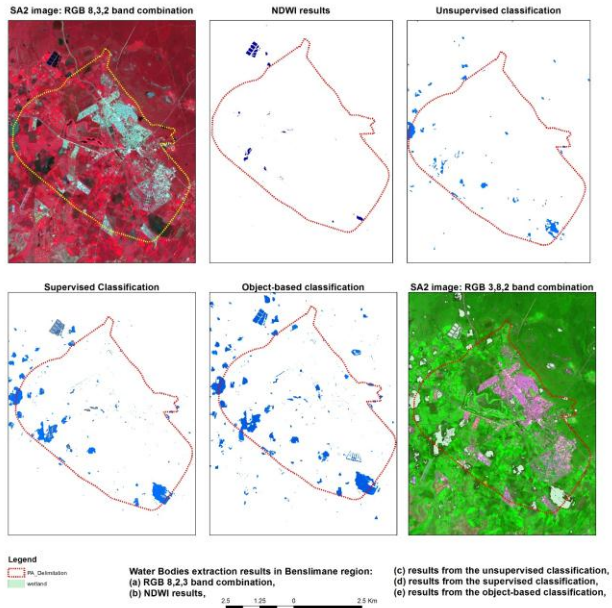


Figure 7. Extraction of dayas by different methods used in this study

Validation of the results:

The control of the classification methods using in this study is done on two levels namely:

- On the basis of a sample of pixels is done on the whole image, with a random spatial distribution and a distribution by random class is 27 random points,
- Based on a sample of two large dayas verified in the field.

Other techniques are used to validate the classification of Sentinel A2 images, in particular the Kappa coefficient (κ) measures the agreement between the classification and the ground truth. A kappa value of 1 represents the perfect chord while a value of 0 represents no chord.

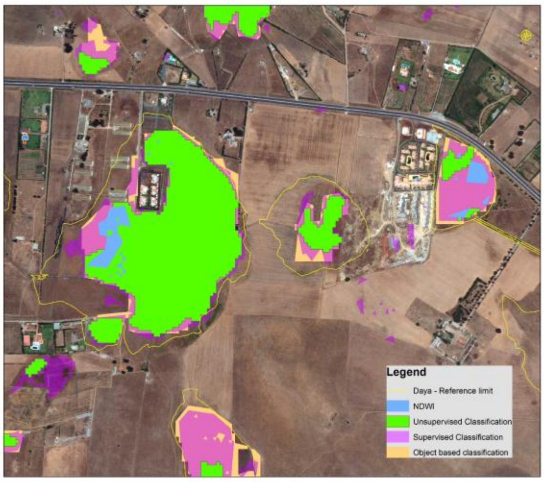
For the validation of the results obtained in this study,

The comparison of the object-oriented approach and the pixel-based approach, improve that the kappa coefficient values of the first approach is about 0.72. On the other hand, for the classification based on pixels, the kappa index around values between 0.35 and 0.4.

The table below presents the kappa index for all classification approaches used.

	NDWI	Unsupervised classification	Supervised classification	Object-oriented classification
Kappa Index	0.35	0.40	0.38	0.72

Table 3. Kappa Index Evaluation Analysis



Water Bodies extraction comparison of methods and results in Benslimane region

Figure 8. Comparison of the results of the classifications adopted in the study

The comparison of the results with the limits of the dayas defined by the topographic surveys shows that the object-oriented classification makes it possible to extract the dayas better than the other classification approaches used. The figure above shows the limits obtained by the different classification approaches in comparison with the topographic survey.
The disadvantage of the object-oriented method is that it can not extract dayas of small sizes. This remains relative to the parameterization of the algorithm and to the basic characteristics of the satellite images processed.
Experimental methods have proved their limits, not allowing to identify all the existing information on the ground This can be object more of search for new algorithms. This being said, the biggest challenge remains to adapt universal methods to local contexts that can integrate the local characteristics of natural and humid environments.

6. CONCLUSION

In the present study, dayas extraction was based on the combination of the two pixel-based and object-oriented approaches with Sentinel A2 satellite data with a resolution of 10 to 60 m.
This type of study can be useful in all areas related to water monitoring. It is also very suitable for use in mountainous areas or any other area to determine changes to specific wetlands.
Since pixel-based methods can not identify the dayas of other areas with low albedo, in this work, the addition of the NDWI index to the pixel-based method has improved the results obtained for both types of supervised and unsupervised classification.
The pixel-based classification can give very good results for the extraction of water, but the number of classes is very important and can take a considerable time to distinguish between the input classes. The biggest advantage of classification by the object-oriented approach is that it can be done very quickly and the results are close to reality.
On the other hand, the disadvantage of NDWI over pixel and object-based classifications is the use of only two bands, which limits the exploitation of all spectral information from satellite imagery.
The idea of combining the two methods for a resolution image of 10 ma gave results that can not be obtained using only the NDWI spectral index or the supervised and non-supervised classification method. supervised, the Kappa index having measured the difference in accuracy of the results obtained.
Although pixel-based methods have been in use for more than two decades and some improvements have been made to them, they are less accurate when used in more heterogeneous areas such as mountainous, snow-covered, cloudy, forested or mountainous areas. urban.
This type of study can be useful in all areas related to water monitoring. It is also very suitable for use in mountainous areas or any other area to determine changes on specific water bodies.
The improvement of the water extraction continues to be developed, by the contribution of the object-oriented method that uses not only the multi-spectral characteristics of the images but also additional characteristics defined by the user for more adaptability to the contexts studied.

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