

# A CLOUD-BASED GISCIENCE LEARNING APPROACH TO SPANISH NATIONAL PARKS

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## Abstract

GIScience learning is the main aim of the GI Learner project, which can be easily achieved using the cloud: open data online from Spatial Data Infrastructures (SDI of Spain). School on the Cloud network has promoted a cloud-based learning approach by dealing with access, sharing and reusability of cloud resources. Thus, based on the results of two European projects, the objective of the article is to focus on improving awareness of sustainability by building itineraries based on places of interest within the best protected areas in Spain, the National Parks, using SDI geoinformation. The methodology of (re)using open data online from SDI by linking cloud knowledge with real Earth and the three selected Parks for a better spatial understanding has been shown to be a very useful way to understand territory. Thus, to improve the learning of sustainable management of National Parks by using cloud computing and SDI it may well prove to be an essential part of environmental education and social responsibility.

**Keywords:** *Spanish National Parks, open data, Maps-based learning, cloud-based GIScience learning, ArcGIS Online, WebGIS*

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## 1. INTRODUCTION

Increased use of the cloud opens a new window to virtual visits which allows students to approach National Parks. They can visit those close to their schools by practising outdoor learning, but they can also get know those far from where they live.

Taking as a starting point, the concept of landscape agreed by the European Landscape Convention (2000) and the didactic premises that it sets out regarding the inscription of necessary learning, we are aware of the multiplicity of resources available today which contribute positively to develop the sensitivity and ethical sense of students and teachers towards landscapes in general, and protected natural areas in particular. Multiplicity responds

both to the increasing availability of web resources and geographic information offered by the cloud, as well as accessibility to new devices such as GPS, tablets or smartphones, which has meant a generalization in access to georeferenced information.

This article aims to bring together different types of landscapes in three Spanish National Parks for students in commemoration of the first centenary of: the first law regarding Spanish National Parks which was enacted in 1916 and the first National Park declared in 1918. The work methodology can be carried out on other Spanish National Parks, there are as many as fifteen National Parks. However due to a question of space only three were selected.

The origin of the concept of National Parks worldwide goes back to the International Union for Conservation of Nature (IUCN), founded in 1948, whose main objective was the development and promotion of scientific programs of nature preservation. Together with the United Nations, it developed the Global Strategy for Conservation of Nature, the basic document of the international conservation movement. It defines a protected area such as: "A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (IUCN, 1994). One of the categories under the management of protected areas is the National Park. Described by Leroux *et al.*, (2010) as large natural or near natural areas set aside to protect large-scale ecological processes, along with being complemented with species and ecosystems characteristic to the area. It provides a foundation for environmentally and culturally compatible, spiritual and scientific education as well as recreational and visitor opportunities. But, educational awareness of nature should be taken into account in order to minimize disturbance. Careful planning and implementation of research and other approved activities should also conserve cultural and spiritual values associated with nature (Dudley, 2008).

However, the first National Park in the world precedes this classification in categories, among the first of its kind in the world: Yellowstone (USA, 1872) with 8.983 km<sup>2</sup>; Yosemite and Secuoya in California (USA, 1890).

Spain is one of the first countries in Europe to have started the policy of protection of natural areas, and one of the countries with the highest percentage of protected areas in relation to the total area (around 30% of the total territory). The Law of National Parks dates from 1916 and it is promulgated by Pedro Pidal's (the marquess of Villaviciosa) initiative, and later by Eduardo Hernández Pacheco. This law included the aesthetic and landscape concept of a National Park. The first two National Parks were declared in 1918: Covadonga (since 1995 P. N. Picos de Europa) and Valle de Ordesa (155 km<sup>2</sup>).

We are enhancing cloud-based learning possibilities (Lázaro, De Miguel & Buzo, 2017) for three National Parks: Covadonga-Picos de Europa, the first declared National Park and two wetland Parks: Doñana and Tablas de Daimiel (figure 1).



**Figure 1.** National Parks location based on the official information of the Ministry for Agriculture and Fisheries, Food and Environment (MAPAMA)

Located in very different parts of Spain, from the northern Eurosiberian region in Picos the Europa National Park, with no water problems, to the Mediterranean ecosystems in the South with severe water shortages during the summer in Doñana and Tablas de Daimiel which are very important wetlands for bird life and biodiversity.

They represent different ecosystems (table 1) within the Natura 2000 Network which must be preserved. Thus, the culture of conservation to preserve and conserve those large territories of wild nature with a geological and landscaping singularity, in addition to a rich biodiversity, is important.

**Table 1.** Main characteristics of the selected National Parks (in order of establishment)

| Name (established)                                  | Area (ha) | Provinces                 | Ecosystem                                                             | URL Official site                                                                                                                                                                 |
|-----------------------------------------------------|-----------|---------------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Picos de Europa (created 1918 and expanded in 1995) | 64,660    | Asturias, León, Cantabria | Eurosiberian. Atlantic forest on limestone formations.                | <a href="http://www.mapama.gob.es/es/red-parques-nacionales/nuestros-parques/picos-europa/">http://www.mapama.gob.es/es/red-parques-nacionales/nuestros-parques/picos-europa/</a> |
| Doñana (1969)                                       | 50,720    | Huelva                    | Mediterranean: coastal wetlands and marshes very attractive to birds. | <a href="http://www.mapama.gob.es/es/red-parques-nacionales/nuestros-parques/donana/">http://www.mapama.gob.es/es/red-parques-nacionales/nuestros-parques/donana/</a>             |
| Tablas de Daimiel (1973)                            | 1,908     | Ciudad Real               | Mediterranean: in the wetlands that attracts primarily waterfowl.     | <a href="http://www.mapama.gob.es/es/red-parques-nacionales/nuestros-parques/daimiel/">http://www.mapama.gob.es/es/red-parques-nacionales/nuestros-parques/daimiel/</a>           |

Source: Ministry for Agriculture and Fisheries, Food and Environment (MAPAMA)

Protection requires the limitation of the number of visitors in some cases (López *et al.*, 2014), especially when their demand is excessive regarding the conservation of the park as can be seen in table 2. These limits have been introduced in Doñana. Many authors such as Balmford *et al.* (2015) speak about the risks of visits to protected areas.

**Table 2.** Number of visitors (2000-2015)

| National Park   | 2000       | 2005       | 2010      | 2015       |
|-----------------|------------|------------|-----------|------------|
| Picos de Europa | 1.869.063  | 1.939.803  | 1.610.341 | 1.913.858  |
| Doñana          | 385.563    | 376.521    | 341.961   | 300.287    |
| Tablas Daimiel  | 115.503    | 123.413    | 398.742   | 192.025    |
| Total 15 N.P.   | 10.252.799 | 10.728.378 | 9.610.447 | 14.429.535 |

Source: Ministry for Agriculture and Fisheries, Food and Environment (MAPAMA)

The Spatial Data Infrastructure centralized in the IDEE, coordinated by the Spanish National Geographic Institute (IGN) offers increased open geodata as a Web Map Service (WMS) (Lázaro, Izquierdo and González, 2016; Álvarez and Lázaro, 2017). This data can be seen on the SignA viewer (Lázaro, Álvarez and González, 2015), the node of the IDEE. There are at least three layers regarding Natura 2000 Network, which include Spanish National Parks and Protected European Areas: Habitats Directive Sites and Birds Directive Sites. For each Park, the information obtained corresponds to the last update (December 2016) and comprises the layers in vector format (shapefile) with the limits of the Park; the Peripheral Areas of Protection (ZP – Zona de Protección), which is the space adjacent to the Park with a legal regime that allows negative environmental impacts in the Park to be cushioned; and the Area of Socioeconomic Influence (AIS), which consists of municipalities that contribute land to the Park and in some cases adjoining municipalities.

These layers have been added to a web map on the ArcGIS Online WebGIS with the purpose of improving knowledge of the natural and cultural values of different unique spaces and their landscapes. WebGIS is a very useful resource for learning aims inside and outside the classroom (Lázaro, De Miguel and Morales, 2017). The storytelling of National Parks and some key activities enhance a social conservationist conscience. This will be added to the initiative of Atlas Digital Escolar (De Miguel *et al.*, 2016) to be used by teachers and students in lessons.

We will explain the general objectives of the activities suitable for different levels: training secondary school teachers and secondary school students. Active methodology using web map-based learning jointly with cloud-based learning will be useful for learning aims. The background of the three Parks suggests an itinerary possible to follow, bringing the student through the virtual and real Park. All this information will be available online, so that the Parks can be worked on virtually and real way, helping to link representations and the real world.

## 2. OBJECTIVES

The main objective of approaching National Parks is to have a better knowledge of landscape and biodiversity that fosters social concern of conservation and contributes to the sustainable management of landscape.

To achieve this it has been necessary to work on environmental education and on improving lifelong learning aims such as spatial thinking, citizenship, digital competencies and collaborative work. We have focused on:

- Demonstrating how these spaces are a source of knowledge and environmental education in both formal and informal education and promote quality environmental education.
- Developing spatial skills, spatial knowledge and development of sustainable attitudes and actions on the territory that promote the improvement of knowledge of the natural and cultural values of the National Parks.
- WebGIS which allows geographical information and different types of layers (images, terrain, scale and others) to be captured or collected, stored, processed, transformed and manipulated, through their management and analysis in order to be interpreted and visualized for communicating.
- Promoting digital competencies, bringing the diversity of available technologies closer together for a better understanding and appreciation of space. Digital competencies have been extended to Google Drive for sharing material, Nearpod for voting and Flipboard for organizing news, among others.
- Learning about geolocation tools and digital map tools, using ArcGIS Online.
- Showing interest in and respect for the work of others in all project tasks.

### 3. METHODOLOGY

A WebGIS has been created to acquire a deeper understanding of the landscape and the above objectives. Collecting information from official cartography and geodata from the National Spatial Data Infrastructures (SDI) and using information from other sources, such as: A Creative Commons License (public) and news in different digital formats (newspapers, magazines, scientific magazines...) is the first step to create the WebGIS.

The content of each Park is shown at selected places of geographical interest (Crespo *et al.* 2018) for education or geolocated places which stand out in relation to the natural and cultural values of the space. Itineraries are established with various points of interest in relation to the values of National Parks. Making profiles with information on slopes, distances and location of reference points are downloadable from mobile terminals. A set of original high-definition georeferenced images and key links related to those images have been provided jointly with other open information of institutional pages (OAPN, AEMT, IGN, IGME) or geographic viewers and virtual globes (e.g. Iberpix or Google Earth). Key questions and comments related to each point of educational interest have been proposed by the teaching staff.

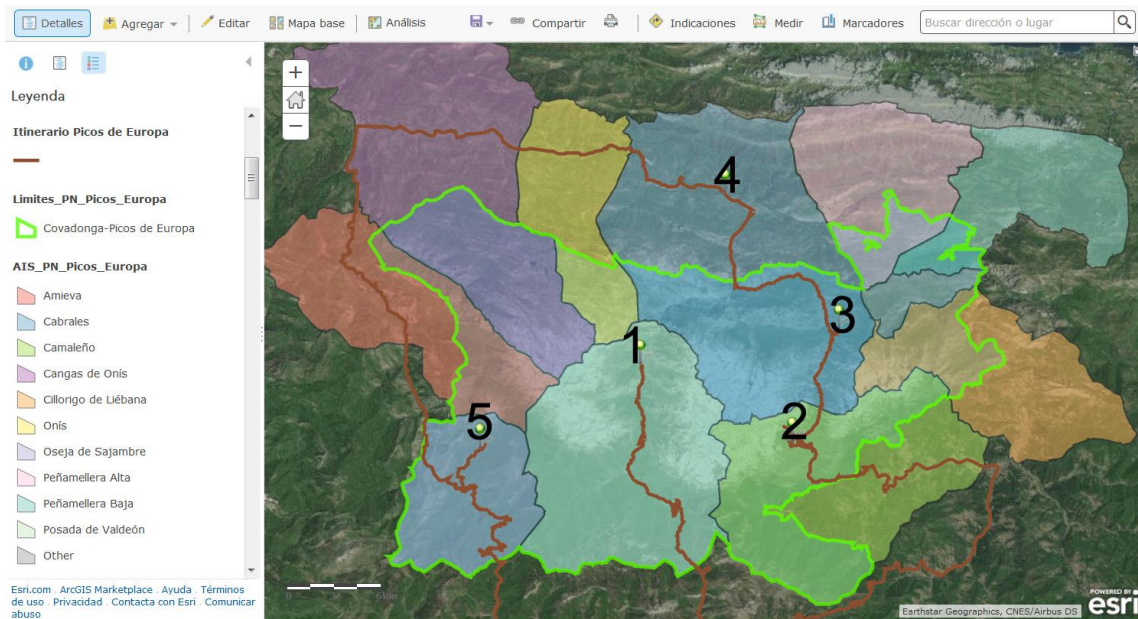
The three Parks already cited have served to exemplify map-based learning with the map on the cloud using GIScience (Lázaro, De Miguel and González, 2017).

### 4. PICOS DE EUROPA

This is an amazing landscape of gorges, valleys, lakes, depressions and gullies that the Quaternary glaciers and rivers carved into a massive formation of limestone (IGME, 2010) originally coloured by the Atlantic forest with alternation of small forests of Mediterranean character (González et al, 2004, 2007). There are two main rivers the Cares and the Deva, both are the main salmon rivers of the Iberian peninsula.

Several endemic plant species are to be found on high mountains and there is the unique European autochthonous forest of Tilos. The Park is also rich in fauna (amphibians, reptiles, birds and terrestrial mammals) very representative of the Iberian peninsula such as the brown bear or the grouse. The traditional agro-livestock has preserved landscape and created a unique mosaic of forest, scrubland and grassland, which has become the habitat of many species. The Picos de Europa and Monfragüe Parks are the only Spanish National Parks with population living inside them.

There are 30 paths which are perfectly organize. We have selected the main part of the Park represented in one itinerary beginning at Picos de Europa Caín de Valdeón and ending at Soto de Sajambre (figure 2) 200 km to be done by car with five main stops.



**Figure 2.** Municipalities within the Park and the Picos de Europa Caín de Valdeón - Soto de Sajambre. itinerary (in brown), the stops are represented by pins and the extension of the Park by a green line. Source: Based on MAPAMA and IGN open data.

There are five places of interest (figure 2): (1) Cain (Tila); (2) Alive Mines (Camaleño); (3) Sotres (Cabañas and Cabrales); (4) Limestone Peak of Bulnes and (5) Hayedo de Soto de Sajambre (From the shelter of Vegabaño) (table 3). It is advisable to visit in spring or early autumn, when temperatures are not extreme and you can appreciate a change in the scenery. The fog in autumn and winter make it impossible to visit the Limestone Peak of Bulnes. One must leave one's car in the Hotel Aliva car park and walk along a path of low difficulty that leads to the Alive mining complex (2.5 km/ 35-40 minutes).



**Table 3.** Main geographical places of interest (stops) within the selected itinerary in N.P. Picos de Europa

| Interest place             | Caín (Tila)                                                                                                                                                                                                                                                                                                                                   | Alive Mines (Camaleño)                                                                                                                                                                                                                      | Sotres (Cabañas and Cabrales)                                                                                                                                                                                                                                                                       | Limestone peak of Bulnes                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Hayedo de Soto de Sajambre                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Why?</b>                | The sickle of Caín is a valley created by glacial processes with fluvial deposits. Rides and folds on limestones come from Hercynian orogeny. Los Molinos and Jarda are two karstic springs. The small village of Caín de Valdeón traditionally used to produce Tila.                                                                         | Mining of zinc and lead in Espinama (Liébana, Cantabria), created in 1853 by the Real Asturiana Mining Company, abandoned in 1989.                                                                                                          | Sotres is the highest town in all Asturias, the area of Cabrales is well known for its cheese culture ("Cabrales Cheese"), thus there are many traditional shepherd's huts.                                                                                                                         | Biodiversity: eagles, vultures (e.g.bearded) some Urogallos, Rebeco ( <i>Rupicrapa rupicrapa</i> ), brown bears, wolves, wild boar, roe deer, wild cats, martens, weasels, antlers, among others. More than 2000 different vegetation species.                                                                                                                                                                                                                                      | Vegabaño is a mountain pass in a meadow at an altitude of 1,432 m. It is surrounded by a forest of beech and oaks. Soto de Sajambre is the closest village. It is in walking distance.                                                                                                                                                                                                                                                      |
| <b>Learning objectives</b> | -To find out about the topographic profile of the route.<br>- To identify: (i) the characteristics of the environment and (ii) the species <i>Tilia Platyphyllos</i> .<br>- To learn georeferencing.<br>- To understand what can and cannot be done inside different zones of the park.                                                       | - To analyse the evolution of these mines, the importance of their production and why they stopped being exploited.<br>- To know how to search for information autonomously and analyse it.<br>- To become aware of environmental problems. | -To understand the "Cabrales Cheese" culture (mainly constructions, traditions and gastronomy) and landscape.                                                                                                                                                                                       | - To introduce the concept of geological and natural landscape.<br>- To choose a suitable scale either 1: 25,000 or 1: 50,000, to locate the place on a map.<br>- To relate the edaphic system, flora, fauna and climate characteristics.<br>- To observe different tourist and mountaineer routes of the valleys and the importance of good management.<br>- To be aware of the fragility and value of the landscape and the different levels / degrees of protection in the Park. | - To learn about relict forest and become aware of its high fragility.<br>- To detect factors that have made the survival of beech and oak trees possible such as orientation, humidity or climate.<br>- The use of mobile applications, apps, and information searches on computing devices to locate, georeferences and look for information about the place.<br>- To become aware of the environmental problems affecting the landscape. |
| <b>Activities</b>          | -Georeferencing the starting point and the end of the route prior to departure.<br>-Observe the topographic profile of the route that it is going to be carried out.<br>-Take pictures or do drawings in order to identify the species <i>Tilia Platyphyllos</i> (leaf type, arrangement of branches, fruits, bark, and height among others). | -Georeferencing the exact place of the mine on a mobile application.<br>- How does mining laundry work?<br>- Analysing the environmental problems of this type of activity.                                                                 | -Georeferencing the exact location of every stop and record the whole itinerary on a mobile application.<br>-Ask about the main steps necessary to elaborate Cabrales cheese.<br>-Observe and describe the landscape (grazing huts and caves for the ripening of the cheese) and clouds of the sky. | -Locate on the 1: 50,000 IGN map the place visited, georeference it and see the viewshed.<br>Make a topographical profile with vegetation changes.<br>-Identify the most interesting inactive glaciers of the landscape and evaluate the beginnings of the routes along valley. Is it possible to make a tourist pass?<br>-Look for any changes produced by antropic action and launch hypotheses about the evolution and future of this area.                                      | -Georeferencing the exact place on the itinerary on the mobile application and locate the exact point on the IGN 1:50,000 map<br>-Analising the characteristics that beech and oak trees need to survive (relief, soil, orientation, humidity, weather among others).<br>-Pointing to conclusions about its state and sustainability.                                                                                                       |

## 5. DOÑANA

Doñana was named a World Heritage Site by UNESCO in 1994. It was previously declared a Biosphere Reserve in 1980 and was included as a wetland of the Ramsar Convention in 1982. Thus, Doñana is part of the Natura 2000 network.

These important declarations came about as a result of biodiversity importance. Around one thousand different plant species and more than 200 birds as well as protected mammals e.g. the Iberian lynx, fish, reptiles and amphibians are found there.

UNESCO has put the spotlight on Doñana because of the increase in the number of threats that hover over the Park:

a) Unsustainable management of water, which could be solved by providing water from rivers further away or other rivers. There are two main water problems which mean that water input has been reduced drastically to around 20%. One problem derived from overexploitation of the aquifer through agriculture (vineyard and olive tree irrigation and intensive crops under plastic such as strawberries) which alters its own hydrology (rivers and streams) and the channeling of the Guadiamar river (WWF, 2009). The second is due to the dredging of the Guadalquivir river for the transit of ships to the port of Seville. The level of the river is descending and so sea water is being introduced onto the land and damaging biodiversity. Salinisation processes have begun on the aquifer system.

b) Gas Natural has been extracting methane since the nineties and gas wells are being constructed inside the Park. Four gas wells have been proposed, two of them inside the Park which experts consider as incompatible activity for Doñana National Park.

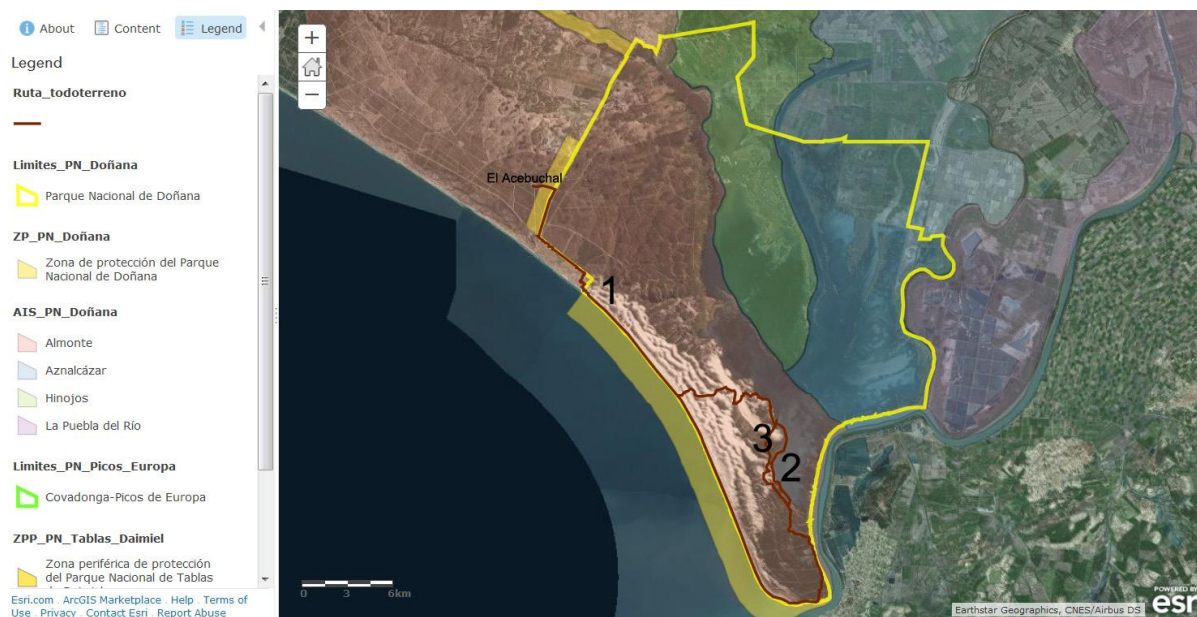
c) The Aznalcóllar mine was authorised to restart activity in 1999. Mining contaminates and many ecological disasters happened in the huge catastrophe in 1998, which spread contaminated water from the mine to Doñana. Consequently, during the following days 30 tons of fish died as well as 170 kilos of crabs and amphibians (WWF, 2002). Three years of intensive work and around €400 million were necessary to solve the main part of the problem. Mining is the main source of employment in this deprived area. Thus, it appropriates environmental management of the mine before and after the disaster.

d) The last fire (June-July 2017) that devastated more than 8000 ha, although nature is beginning to regenerate the forest, the ecological restitution would be advisable.

There are different landscapes (MAPAMA, 2017) that can be appreciated (Figure 3):

1. Mobile dunes and beaches, sand mountains which move near the beach towards the inner land. Some colonized because of rushes (*juncus subulatus*) and juniperus on the upper part (*Juniperus oxycedrus subsp. macrocarpa*). While they move, they hide the Mediterranean forest that reappears after the dunes have disappeared.
2. Marshlands, locally called “marismas”, are wetlands flooded by streams which depend on the rain/rainfall, migrating birds nest and rest during winter and breed here. Flamingos (*phoenicopterus ruber*) as well as ducks, goose and concentrations of other anatidae families of birds are easily seen on the marshes.
3. Mediterranean forest and bushland, with cork oaks, reforested pine trees, arbutus and Mediterranean bushes.





**Figure 3.** Doñana extension (yellow line) and municipalities within the Park. Itinerary to be visited (brown line). The three ecosystems of the Park (1) dunes and beaches, (2) marshes and (3) Mediterranean forest. Source: Based on MAPAMA and IGN open data.

The number of visitors to the Park has decreased due to a strict law, perhaps in relation to the given European Chart on Sustainable Tourism in 2006. Thus, there is a recommended organized route starting at El Acebuche visitors centre which returns to the same point which is around 63 kilometres long and takes approximately four hours by a 4x4 car.

**Table 4.** Main geographical interest stops within the selected itinerary in N.P. Doñana

| Interest place             | Visitors centre: El Acebuche                                                                                                                                                                                                                                                                                        | Dunes and beaches                                                                                                                                                                                                                                                                                                                                                                               | Marsh called “Marisma”                                                                                                                                                                                                                                                                                                                                                          | Mediterranean forest                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Why?</b>                | The beginning and end of the itinerary. There is a general exhibition about Doñana N.P. I Booking in advance is advisable if using a 4x4.                                                                                                                                                                           | Mobile dunes move around 6 m a year. They hide the forest, which after its passage, is regenerated again.                                                                                                                                                                                                                                                                                       | Wet zone for migrating birds’ nests and breeding during winter. Some vegetation is seasonal and depends on the predominance of salt water or fresh water from steams and rainfall.                                                                                                                                                                                              | Cork oaks, arbutus, olive trees and pine trees of reforestation lend their branches to nesting and sheltering birds. There are different hunting species (wild boar, deer, hares and rabbits.) and protected endangered species such as the Iberian lynx or the imperial eagle, among many others.                                                                                                                                              |
| <b>Learning objectives</b> | Get an overview of the Park and its problems before the visit.                                                                                                                                                                                                                                                      | Understand the movement of the dune in the context of the Doñana dune landscape.                                                                                                                                                                                                                                                                                                                | Understand marsh landscape.                                                                                                                                                                                                                                                                                                                                                     | Understand the forest in a context of sandy soils with the organic inputs of the forest itself.                                                                                                                                                                                                                                                                                                                                                 |
| <b>Activities</b>          | -Find out about the main ecosystems to be visited.<br>-Install a GPS program on your mobile device (eg Maps of Spain, OruxMaps, Runtastic, Map Plus or Motion X GPS) to record the track and track the points of interest). If possible it should be accompanied by a photograph showing the interest of the place. | -What is the difference between a mobile dune and one that is not? How does vegetation act in each of them?<br>-What is the predominant wind? In what direction do you think the dunes will continue to move?<br>-Which parts does a dune consist of?<br>-Is it safe to walk on the dunes? Explain your answer.<br>-Take a point through which you have passed and observe the dunes with ease. | -Investigate what is meant by Lucio, what is the difference between high and low tide ... (you can get help from the MAPAMA website)<br>-Observe and take some images of the vegetation, name them and add the name in Latin.<br>-Take the geographical reference of the waypoint from where you took the image.<br>-Is the “Marismeño” ecosystem fragile? Explain your answer. | - Do you recognize any of the species of vegetation? What climatic and edaphic conditions do they need to survive?<br>-Did you have the chance to see any animals? Which? Do they live permanently in Doñana? Briefly describe their characteristics.<br>-Write down the coordinates of- one of the places you visited and find it on your itinerary.<br>-Have you noticed any problems during the visit to the Park? Give a broad explanation. |

## 6. TABLAS DE DAIMIEL

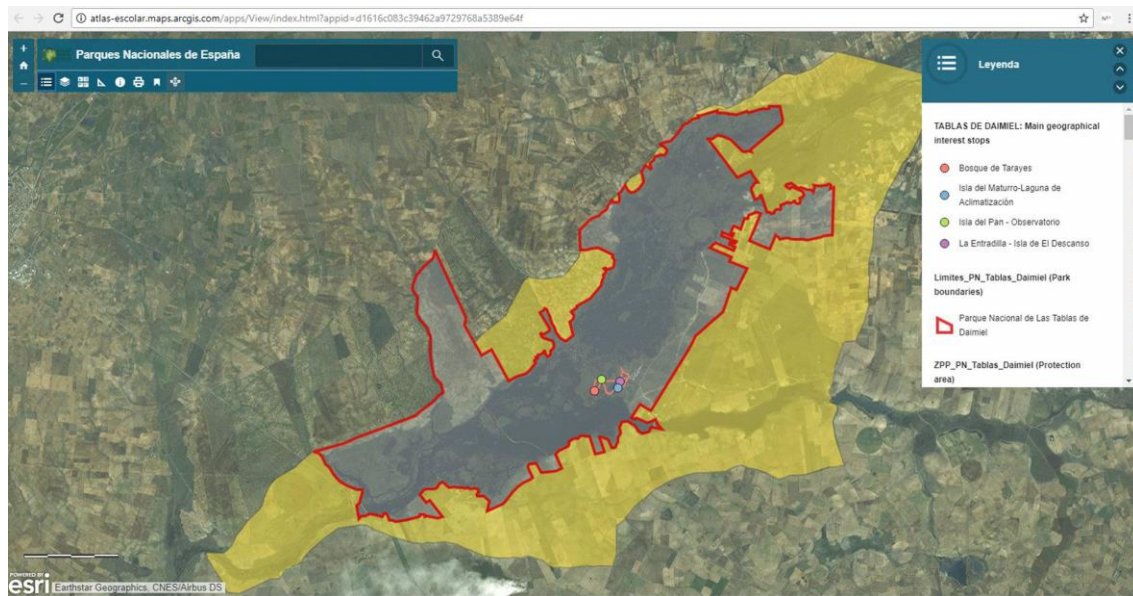
Tablas de Daimiel was declared a National Park in 1973, a biosphere reserve in 1981 and it was included in the Ramsar Convention in 1982. The National Park is located in the municipalities of Daimiel and Villarrubia de los Ojos in the province of Ciudad Real. Tablas is one of the few examples in Europe of an ecosystem called “fluvial tables”. This is thanks to the flood of two rivers, the Guadiana, with fresh and permanent waters, and the Gígüela, with salt and seasonal water. This combination of waters leads us to write about salty wetland.

One of the richest features of the Park is the abundance of different animal and plant species. On the one hand, we can emphasise the existence of some fowl: herons, ducks or rattles; some mammals, like wild boars, foxes, rabbits or Iberian hares; and fish, e.g. crab or the American red crab. On the other hand, we can observe different types of plants from the Mediterranean forest.

The National Park presents three major problems:

- a) The misuse of land through agricultural activity and overexploitation of water resources, which is necessary for the lagoon and for some animal and vegetable species to survive. Moreover, the use of chemicals in intensive agriculture dominates the surroundings of the Park.
- b) Low quality tourism in terms of awareness of the population regarding protected areas. Because of this, it is important to carry out tourism related to the environment.
- c) Lack of awareness regarding the values of the National Park which could be fostered through policies and environmental education, including campaigns for farmers who use chemical fertilizers and who harvest in areas surrounding the Park.

To conclude, a set of problems that harm the Park which the study highlights and the diagnosis is carried out by competent authorities of *Master Plan of Use and Management*.



**Figure 4.** Base map for the group of students who will work on WebGIS. Main geographical interest stops. Source: Based on MAPAMA and IGN open data.

**Table 5.** Main geographical interest places (stops) on the selected itinerary in Tablas de Daimiel N.P.

| Place of Interest          | La Entradilla Island – El Descanso                                                                                                                                                                                                                                                                                                                                                                                   | Pan Island                                                                                                                                                                                                                                                                                                                   | Tarayes Forest                                                                                                                                                                                                                                                                                                                          | Maturro Island                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Why?</b>                | La Entradilla is the first island to be found in the Park. It helps to explain how we are going to go about the itinerary (over wooden bridges) and to observe the first birds and explain their relationship with the aquatic environment in the protected spaces from the peninsular interior. From there, we will pass to El Descanso Island, where we will observe the first waterfowl, depending on the season. | Students will learn to observe the phenomenon of the island in Tablas, as well as its relationship with biodiversity and migratory and permanent populations of birds.                                                                                                                                                       | The Tarayes Forest is the fourth geographical point of interest, in which students can observe the growth of shrub species such as tarayes, which is a shrub of reddish colour. This species grows thanks to the humidity of the ecosystem.                                                                                             | The last two stops are on the island of Maturro, where we find our second point of interest: the Acclimation Lagoon, where students can observe a set of different species of anatidas, which can be observed as part of a group or individually, performing all kinds of movements in the water of the lagoon.                                                                                                                                                                                         |
| <b>Learning objectives</b> | <ul style="list-style-type: none"> <li>-Understand the rules of behaviour inside the National Park.</li> <li>-Introduce the study of the environment</li> <li>Identify the characteristics of salty wetland.</li> <li>-Identify the first waterfowl</li> </ul>                                                                                                                                                       | <ul style="list-style-type: none"> <li>-Understand the concept of the flow table</li> <li>-Observe waterfowl, ducks, geese and other water birds.</li> <li>- Understand the difference between migratory birds and native birds</li> </ul>                                                                                   | <ul style="list-style-type: none"> <li>-Observe and take note of the physical characteristics of the tarayes.</li> <li>-Assess and show respect through the protection of plant species.</li> <li>-Observe the type of birds and nests.</li> </ul>                                                                                      | <ul style="list-style-type: none"> <li>-Understand the importance of the values and problems on National Parks.</li> <li>Find waterfowl in the Acclimation Lagoon.</li> <li>Take note of environmental problems and how to aware on them.</li> </ul>                                                                                                                                                                                                                                                    |
| <b>Activities</b>          | <ul style="list-style-type: none"> <li>-Georeferencing the starting point on a GPS (Garmin, Orux Maps, My Tracks)</li> <li>-Install Naturaleza MAPAMA app on a mobile phone or tablet</li> <li>-Take photos of the waterfowl (ducks, goose and other water birds)</li> <li>-Make notes in the field notebook of birds and the characteristics of the salty wetland.</li> </ul>                                       | <ul style="list-style-type: none"> <li>-Georeferencing the Bird - Observatory point</li> <li>Ask students: why do birds migrate? -</li> <li>What factors depend on this mobility of birds?</li> <li>-Make notes of the differences between migratory and native birds</li> <li>-Take photos of two types of birds</li> </ul> | <ul style="list-style-type: none"> <li>-Georeferencing the point as an observatory of the characteristic flora of this island</li> <li>-Take note of the physical characteristics of plant species</li> <li>-Make notes of the birds that nest in this type of shrub forest</li> <li>-Photographing plant and animal species</li> </ul> | <ul style="list-style-type: none"> <li>-Georeferencing the point of the island of Maturro and finishing the track in the Acclimatization Lagoon</li> <li>-Make notes on the birds of Acclimatization Lagoon</li> <li>-Make brief conclusions about the protection and care of National Parks</li> <li>-Deliver the field book with all the activities and notes taken during the visit to the Park, as well as preparing a dissertation on the values and problems of Las Tablas de Daimiel.</li> </ul> |

The students’ approach to the problems and values presented in Tablas de Daimiel National Park was carried out using WebGIS (figure 5), images (figure 5a) and the News (figure 5b). Thus, three work groups were considered using the application nearpod.com. Each group uploaded a presentation focused on a particular aspect and they voted to go to the most voted for Park (figure 5c).

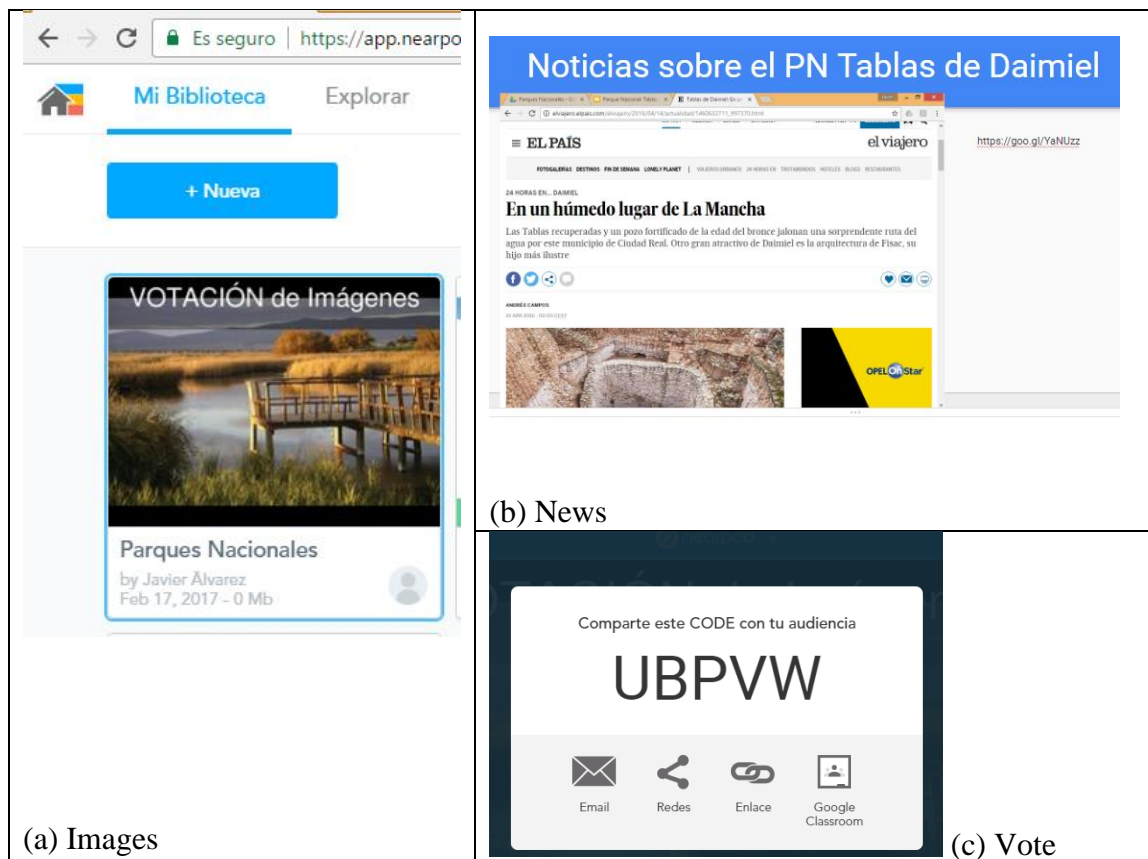


Figure 5. Activities online

Students enjoyed the field-work and showed satisfaction after their lesson. They even showed eagerness to learn about more features of Spanish National Parks, as well as proposing other visits to other parks, because they told us that they had learnt more in the National Park than from the unit on the environment and doing activities in the classroom.

## 7. LEARNING RESULTS

The project material and activities invited students to use the cloud in order to learn about protected areas in Spain. Teachers have created material, using open data, for this aim.

The main observed learning results have demonstrated that students showed awareness of values and problems. Students were motivated when creating new scenarios and using a wide variety of resources for significant learning.

The material proved to be very useful before the field trip to Las Tablas de Daimiel. Spatial and digital competencies have improved as students can do an analysis of the interactive map, which integrates the SDI and geographical information.

An important way to improve learning is a field trip to the National Parks landscapes (Lázaro, De Miguel and Buzo, 2016).

## 8. CONCLUSIONS

To learn about Spanish National Parks is possible using open data on the cloud. The geodata can be integrated on a WebGIS as useful figures and layers. Therefore, improving learning by using geo-technologies on the cloud is somewhat achievable. This is a new way of obtaining better knowledge of landscape and biodiversity that fosters social conscience of conservation and contributes to a sustainable management of the landscape.

WebGIS has promoted digital and GIS competencies on collecting, storing, processing, transforming and manipulating geographical information, through its management and analysis in order to interpret and visualize it to communicate this type of information, bringing the diversity of available technologies closer together for a better understanding and appreciation of space. Linking virtual knowledge with real Earth is the objective of this work that has been undertaken.

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## REFERENCES

- Álvarez, J. and Lázaro, M.L. de, 2017. Spatial Data Infrastructure and Learning Geography *European Journal of Geography* 8 (3), 19-29.
- Balmford A, Green JMH, Anderson M, Beresford J, Huang C, Naidoo R, *et al.* 2015. Walk on the Wild Side: Estimating the Global Magnitude of Visits to Protected Areas. *PLoS Biol* 13(2): e1002074. doi:10.1371/journal.pbio.1002074
- Crespo, J.M., Cruz, L.A., Gómez, M.L. 2018, Diseño de itinerarios didácticos en parques nacionales españoles aplicando tecnologías de la información geográfica (Didactic itineraries in Spanish national parks using GEOICT). *Espacio Tiempo y Forma. Serie VI, Geografía*, 11.
- De Miguel González, R., De Lázaro y Torres, M.L., Velilla Gil, J., Buzo Sánchez, I. and Guallart, C. 2016. Atlas Digital Escolar: Internet, geografía y educación. *Ar@cne. Revista Electrónica de Recursos de Internet sobre Geografía y Ciencias Sociales* Retrieved from <<http://www.ub.edu/geocrit/ aracne/ aracne-212.pdf>>.
- Dudley, N. (Ed.), 2008. *Guidelines for Applying Protected Area Management Categories*. IUCN, Gland, Switzerland.



- Europe, C. O. (2000). *European Landscape Convention*, Florence, 20 October 2000.
- González González, M. J. and Villoldo Álvarez, A. 2004. Contradicciones en la administración y la gestión sostenible de los espacios naturales: El Parque nacional de los picos de Europa ¿Espacio real o inventado? *Revista internacional de marketing público y no lucrativo*, 1(1): 111-124.
- González González M. J. 2007. L'administration et la gestion durable des espaces naturels: Le parc national des «Picos de Europa» Espagne. *Revue Géographie des Pyrénées et du Sud-Ouest*, 23 : 113-125.
- IGME. 2010. *Guía geológica de los Picos de Europa*. Everest. <http://www.igme.es/LibrosE/GuiasGeo/picosdeeuropa/index.html#42>
- IUCN, 1994. *Guidelines for Protected Area Management Categories*. CNPPA with the assistance of WCMC, Cambridge, UK.
- Lázaro, M.L. de, Álvarez, J. and González, M.J. 2015. “Aprender geografía de España empleando SignA” en *Investigar para innovar en la enseñanza de la Geografía*. Universidad de Alicante, pp.25-39.
- Lázaro, M.L.; Izquierdo, S. and González, M.J. 2016. “Geodatos y paisaje: De la nube al aula universitaria” (Geodata and Landscape: From the Cloud to Lectures). *Boletín de la Asociación de Geógrafos Españoles*, 70: 371-391. DOI: 10.21138/bage.2175. English version retrieved from: <http://www.age-geografia.es/ojs/index.php/bage/article/viewFile/2245/2132>
- Lázaro, M.L.; De Miguel, R. and Buzo, I. 2016. Outdoor Learning and Geography on the Cloud: A Challenge for the European “School on the Cloud” Network. *The International Journal of Technologies in Learning*: 23 (3): 1-13. DOI: 10.18848/2327-0144/CGP. © Common Ground Publishing.
- Lázaro, M.L. de, De Miguel, R. and González, M.J. 2017. “Flipped teaching: A useful method for cloud-based GIScience learning” in Doukas and Kostopoulos *Educational Design and Cloud Computing in Modern Classroom Settings*.
- Lázaro, M.L. de, De Miguel, R. and Morales, J.F. 2017. WebGIS and geospatial technologies for landscape education on personalized learning contexts. *ISPRS International Journal of Geo-Information*. 6(11):350.
- Lázaro, M. L. de, De Miguel, R., & Buzo, I. (2017). El Proyecto School on the Cloud: Lecciones Aprendidas= School on the Cloud Project: Lessons Learned. *Espacio Tiempo y Forma. Serie VI, Geografía*, (10), 103-120.
- Leroux, S. J., Krawchuk, M. A., Schmiegelow, F., Cumming, S. G., Lisgo, K., Anderson, L. G., & Petkova, M. 2010. Global protected areas and IUCN designations: Do the categories match the conditions? *Biological conservation*, 143(3): 609-616.
- López Bonilla, J.M, Boerasu, A.E, López Bonilla, L.M. 2014. Perfiles de los visitantes en el turismo de naturaleza: Análisis exploratorio en el entorno de Doñana. *International Journal of World of Tourism*, 1 (1). Recuperado de: [http://www.aloj.us.es/ftf/Inter\\_Journal\\_World\\_Tourism\\_Vol1\\_Num\\_1\\_2.pdf](http://www.aloj.us.es/ftf/Inter_Journal_World_Tourism_Vol1_Num_1_2.pdf)
- WWF. 2002. *Mining in Doñana*. Available on [http://assets.wwf.es/downloads/mining\\_in\\_donana\\_english.pdf](http://assets.wwf.es/downloads/mining_in_donana_english.pdf)
- WWF. 2009. *Environmental flows in the marsh of the National Park of Doñana and its area of influence*. Available on [http://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/Environmental\\_flows\\_in\\_the\\_marsh\\_of\\_the\\_National\\_Park\\_of\\_Donana.pdf](http://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/Environmental_flows_in_the_marsh_of_the_National_Park_of_Donana.pdf)