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Master´s Programme Geomatics

Master´s Thesis

of

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Development of a data platform for the Cultural Heritage Project Maulbronn Monastery

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Terms of reference
Master Thesis
of
Jesus Nicolas S a n c h e z

Development of a data platform for the Cultural Heritage Project Maulbronn Monastery

INTRODUCTION
Maulbronn Monastery is a World Heritage site of national importance. Since several years the Faculty of Information Management and Media is working in the field of data acquisition and visualization there. Meanwhile, there exists a data pool of huge variety and various data types, like DTMs, aerial photographs, TLS point clouds, CAD files, coordinate lists, videos, and several more.

A management platform for the administration of this valuable treasure of data set is needed. Because of the faculty's IT landscape ArcGIS Server and Geoportal Server (with the Geoportal Genie extension) are envisaged.

OBJECTIVES
The proposed thesis can be subdivided into the following subparts:
- Studying and evaluating of different geoportal solutions in the literature (including Internet).
- Analyzing of different approaches of visualization and administration.
- Comparing the existing ArcGIS Server and Portal for ArcGIS infrastructure with the anticipated benefits of using Geoportal Server for the purpose.
- Implementing the Maulbronn data into the best solution.
- Visualization of all available data in a georeferenced manner in the server solution.
- All information should be accessible via keyword search
- The server should allow to search by database and spatially (by graphics).

DATA
- Aerial photographs, orthophotos
- DTM
- Topographic maps
- TLS and UAV point clouds
- Photographs, videos
- Land use, diches as shape files
- Documents, theses, literature, …

REFERENCES
https://www.esri.com/en-us/arcgis/products/geoportal-server/overview
https://www.hs-karlsruhe.de/imm/chp/immchp-maulbronn/

The written part of the thesis (*.doc), the slides of the presentation (*.ppt), the poster (*.ppt) along with the data and results have to be handed over on a mobile drive.

Duration:	6 months	1st Referee:	Prof. Dr.-Ing. Heinz Saler
Handing out:	05.06.2019	2nd Referee:	Dipl.-Ing. (FH) Konrad Berner
Closing date:	05.12.2019	3rd Referee:	Prof. Ing. Eloina Coll

Prof. Dr.-Ing. Heinz Saler

Sworn declaration.

This thesis titled Development of a data platform for the Cultural Heritage Project Maulbronn Monastery was prepared by Jesús Nicolás Sánchez Martínez.
I hereby declare on oath that I have written the present work independently and have used no other than the specified aids.
All parts of the work, which are taken in the wording or meaning of publications or lectures by other authors, I have identified as such. The work has not yet been submitted in whole or in part to another examination authority and has not yet been published.

Date, place   Signature

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Glossary of terms

WMS: Web Map Service

DTM: Digital Terrestre Model

GIS: Geographic Information System

URL: Uniform Resource Locator

VPN: Virtual Private Network

SHP: Shapefile

RGB: Red, Green, Blue

HTML: Hyper Text Mark-up Language

CSS: Cascading Style Sheets

1. Introduction and Project aim.

The monastery of Maulbronn is one of the most important monasteries in Germany and it has been declared a World Heritage Site by UNESCO in 1993. It is located at Maulbronn, Baden-Württemberg, Germany.

There have been numerous works of the Monastery and there are a lot of different types of data. Thus, a management platform for the administration and visualizations of this valuable treasure of data set is needed. These different types of data, which are explained in the following chapter.

Since several years the Faculty of Information Management and Media is working in the field of data acquisition and visualization with the Maulbronn monastery, for that reason, different alternatives will be studied to see which one is the most appropriate to perform a Geoportal or Platform for data management. Later the platform will be developed with the solution that has more benefits for our purpose.

To make a complete analysis, the first step is to study examples of platforms or Geoportals already created that have the same objective as this. Then, all the functionalities and options that the Geoportal should have are defined. Finally, a detailed analysis will be done to reach the conclusion of the most optimal solution.

The last step is the creation of the application or Geoportal, publish some data and leave it ready to start working with it.

2. Project data

The data with which this project work is the following:

- Aerial images
- Historical aerial images
- Orthophotos
- RGB images
- Multispectral images
- DTM
- Topographic Maps
- Point cloud laser scanner
- Photographs in general
- Videos
- Documents or articles about the monastery.

As it can see there are a several types of data that is needed to visualize, so for that it is necessary to find a software to store all this information and be able to offer the data in an easy and quick way.

3. Software used

- **ArcGIS**: is a platform for organizations to create, manage, share, and analyse spatial data. It consists of server components, mobile and desktop applications, and developer tools.
  - **ArcMap** is the primary application used in ArcGIS and is used to perform a wide range of common GIS tasks as well as specialized, user-specific tasks. Here is a list of some common workflows that can be performed (e.g. work with maps, print maps, compile and edit SIG datasets, user geoprocessing to automate work and perform analysis, publish map documents as map services using ArcGIS Server, etc.)

  - **ArcCatalog** is an application of ArcGIS that provides a catalog window that is used to create, organize and manage various types of geographic information for ArcGIS for Desktop.

  - **ArcGIS Administrator** helps to administrate ArcGIS for Desktop and to provide valuable information about the installation.

4. What is a Geopotal?

In the article (SDI), a geoportal is defined as a web portal where through the internet, it is possible to search and access the geographic information and different associated geographic services display, editing, analysis, etc.). In addition, this same article states that geoportals are very important to achieve the effective use of geographic information systems (GIS).

In addition, the article (Lanz, 2011) explains the importance of geoportals in society. This article states that Geographic information consumers, professional or casual, use geoportals to search and access the information they need. Thus, geoportals serve an increasingly important role in the sharing of geographic information and can avoid duplicated efforts, inconsistencies, delays, confusion, and wasted resources.

As it can be seen in different articles and news, to realize a Geoportal is a tendency that day after day is used more for multitude of needs. In this work, it is wanted to realize a Geoportal for the conservation of the cultural patrimony. But, before starting to perform the Geoportal, it is very important to carry out a previous study of other Geoportals and the different options that it has.

The article (Ministry of Education, Culture and Sports, 2013) explains the importance of geoportals or GIS platforms to manage the data of cultural heritage conservation. Affirms that heritage conservation information is very valuable and without a tool to manage and consular geographic information such as a Geoportal, it was almost impossible to reuse the absence of mechanisms that would not only have it located, but also share it.

4.1 Examples of Geoportals

One of the most important part of this project is to investigate other platforms and applications in order to extract useful information that can be implemented in this work. Therefore, this chapter will analyse different Geoportal, and some of them are created for the preservation of cultural heritage.

- **Geoportal of Cultural heritage institute of Spain**: Its main objective is to efficiently manage data on the Cultural Heritage of Spain.

  - Link: https://ipce.gvsigonline.com/gvsigonline/viewer_public/8/
  - Software: gvSIG Online to do the map.
  - Analysis: It is a Geoportal that only has the part of the map, in that part, the user has a layer control to activate and deactivate the information that needs to visualize. It is an interesting option but very simple.
  - Photo:

Figure 1: Geoportal of Cultural heritage institute of Spain.

- **Geoportal for the Architectural and Cultural Heritage of Sandinia (Italy).** The objective is to manage and share the data of the architectural heritage of the Sardinia region. Since it is a private website, users who are allowed can have access to enter, view the data in a gallery, edit the associated information with that data and view the data on a map, (according Vacca, Rita Fiorino and Pili, 2018)

  - Link: http://abanni.unica.it/wgis_unica/
  - Software: Web programming.
    - Map: Leaflet.
    - Data base: PostgreSQL.
    - Data Server: Geoserver.
    - Web design: HTML Y PHP, JavaScript y CSS.
  - Analysis: this Geoportal is private. It can only be accessed with a username and password and does not give the option of registration. The user does not have option to download the data. The idea of this Geoportal is interesting since it has a user control, a data gallery that can later be visualized on the map, and some data can be edited on the map.

- Photo:
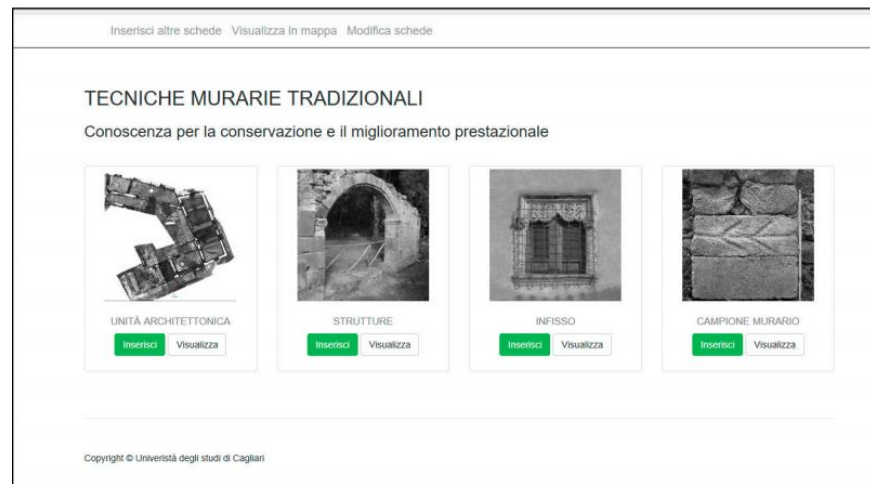
Figure 2 : Geoportal of Heritage of Italy.

Figure 3: Map of the Italy's Geoportal.

- **Geoportal Implementation for Oil and Gas using Geoportal Server:** This Geoportal aims to publish data from the Gas and Oil sector.
  - Link: http://unigis.sbg.ac.at/files/Mastertheses/Full/102901.pdf
  - Software: Geoportal Server.
  - Analysis: The option to carry out the Geoportal with Geoportal Server is interesting since it is an already created platform that it is needed just to install and configure to the user's discretion. The platform has: a map where the data can be visualized, a catalog where all the geoportal data appears and a section to search for data using different filters (keyword, data type, by extension of the map, etc.).

- Photo:

Figure 4: Home page of Geoportal of Oil and Gas.
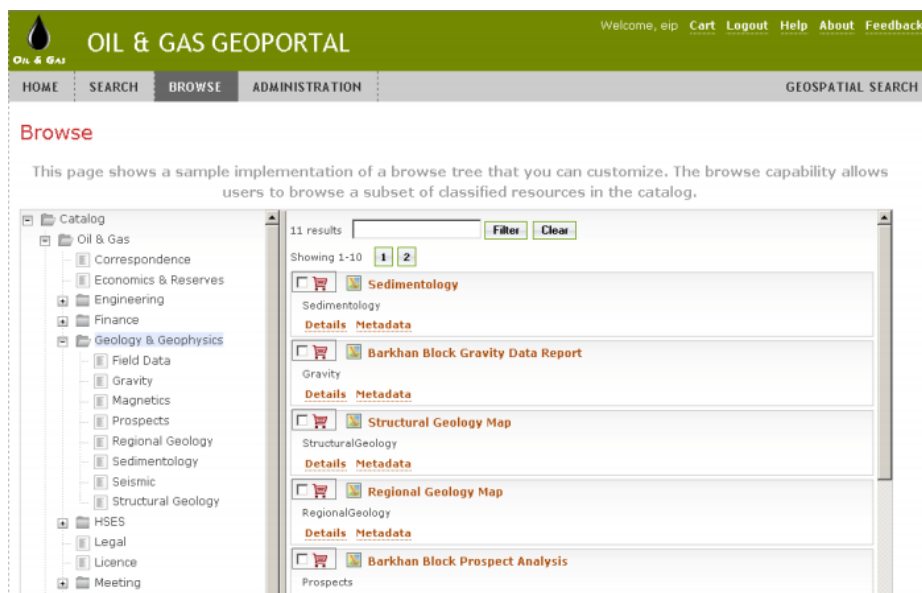
Figure 5: Catalog of Data of Geoportal Server.

- **Geoportal to manage data from the Hochschule Karlsruhe Technik und Wirtschaft:** This is a geoportal created by the university to publish data and be able to share it with professors or students.
  - Link: https://www.imm.hs-karlsruhe.de/geoportal/home/index.html
  - Software: Portal for ArcGIS.
  - Analysis: This Geoportal is also an already created platform, which only has to be configured to the needs of each project, has a powerful user control, data can be published, can be purchased in different groups only for certain users, or it can be Post to all users. In addition, the data can be displayed on an ArcGIS Online map.

- Photo:
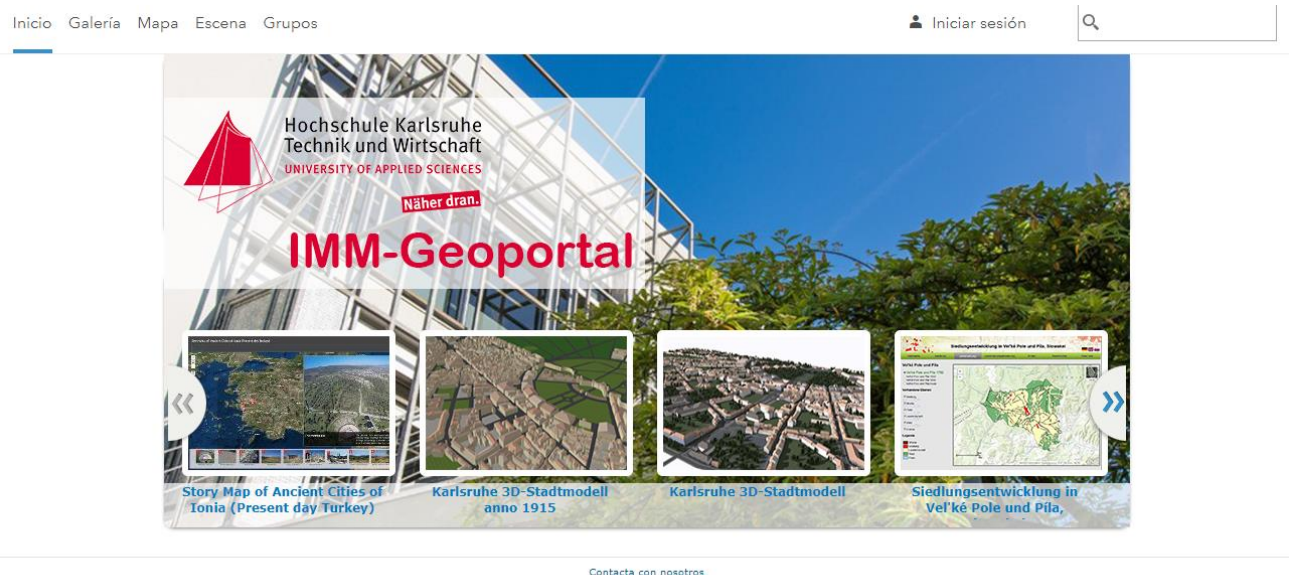
Figure 6: Home page of Portal for ArcGis.
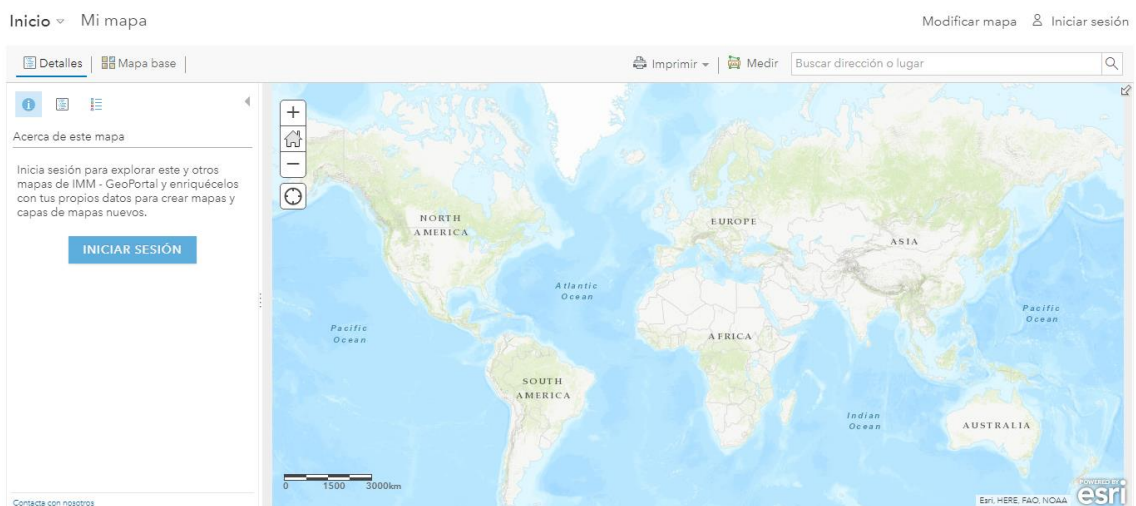
Figure 7: Map of Portal for ArcGis.

4.2 Analysis

In order to a correct analysis (of which of the above alternatives is more suitable to make this project), firstly, it is necessary to know the tools or parts that it is wanted to platform to perform:

Functions:

- Page with information.
- Possibility to register data.
- Search for data using different parameters.
- Be able to visualize the data in a map.

- To register the data with metadata to locate them more easily and have information about what each of it.

- To download the data.

- User control.

- Understand it easily and make it accessible to the user.

As it has been seen in the previous examples, each Geoportal is organized in a different way, with a structure and tools different from the previous one. Depending on the objective and the functions that it is wanted to implement in the Geoportal, one option is better to another.

The analysed geoportals are made with Web programming, GVSIG Online, Geoportal server or with Portal for ArcGIS. From the previous description it can be rule out the option of GVSIG Online due to the few possibilities that it allows. On another hand, the other three options could be valid to perform the geoportal. Because each option has different things. A detailed analysis it has been made to choose the best option.

5. Analysing the options to do the Geoportal

In this section, three different options will be explained and compared to carry out the geoportal. The final conclusion has been obtained with the appropriate option for the Geoportal.

5.1 Portal for ArcGIS

5.1.1 What is Geoportal Server?

It is a component of ArcGIS Enterprise that allows to create and share maps, scenes, applications and other geographic information with other user's organization. To visit all parts of the Geoportal, it is necessary to log in with a username and password. Each user will have their account, which allows to make groups among different users to share information; this information can be displayed on a map where the user can use Widget to have more functions.

The ArcGIS Enterprise portal brings together all the geographic information in ArcGIS Server platform and shares it throughout the organization. With it, it can be done:

- Create, save, and share web maps and scenes.
- Create and host web mapping apps.
- Search for GIS content within the organization.
- Create groups to share GIS information with people.
- Share links to GIS apps.
- Share map and layer packages to use in ArcGIS Desktop.

5.1.2 Parts

- **Home page**: Information will appear where it can be deduced which is the goal of the geoportal. At the front end of the portal, users sign in to search, use, and share content.
  Information about the main goal of the geoportal will appear in this section.

- **Galler**y: Here it is possible to find the most relevant geoportal information. The information it wanted to be found easily.

- **Scene Viewer:** In the ArcGIS Enterprise portal, the Scene Viewer application is used for viewing 3D geospatial content.

- **Map:** This app within the portal website allows to view, design, and save data and web maps. Thinking of it as a canvas in which combine GIS information and services to show the data or make the administrator own map.

- **Groups**: In this part of the Geoportal it is possible to create groups in which certain data will be published, and only people chosen by the creator or administrator of the group will have access to the group. It is an interesting part because in this way it can be chosen with whom it is wanted to share the information.

- **Content**: Here all the data to which have access will appear: Own content, Own Favourites, Own Groups, Own Organization and Living Atlas.

- **Web AppBuilder for ArcGis**: The portal website includes an embedded interactive app for designing and building web applications from web maps. Created applications with Web AppBuilder require no programming knowledge and are HTML-based. It means to work on desktop browsers, tablets, and smartphones without needing a plugin. Web AppBuilder comes with a variety of themes that it can be customize and widgets that allow to deliver advanced functionality such as high-quality printing, geoprocessing, editing, and search.

- User control: Everyone has access to the Geoportal, but there are certain parts to which only logged users have access. In addition, a publisher can decide with which users wants to share the data to be uploaded.

5.1.3 Testing

To have a good concept of how Portal for ArcGIS works, it is necessary to work with the platform and perform basic tasks to be able to find positive and negative aspects for this project. For this purpose, different tasks have been performed:

- ❖ **Create a group**: First a group has been created to study how it works and to be able to save the data.

- ❖ **Publish data:** it is important that all types of data that it is wanted to publish in the Geoportal could be published, so an example of each type of data will be published.

  Before to start to publish data, it is important to know that the data is not stored in the Geoportal, the data will be published in ArcGIS Server. The Geoportal will search the ArcGIS Server data and allow it to be displayed in the platform.

  It is also important to mention that there are two different ways of publishing the data, which will be explained below:

- **From ArcGIS:** all the data that you want to be displayed on the map (layers of hosted entities) will be published.

  Different steps must be performed. First of all it is necessary to go to ArcGIS Administrator to configure the Link that it can be accessible from ArcMap. Click on the option "Portal-Verbindunger verwalten" as you can see in the following image (Figure 8).
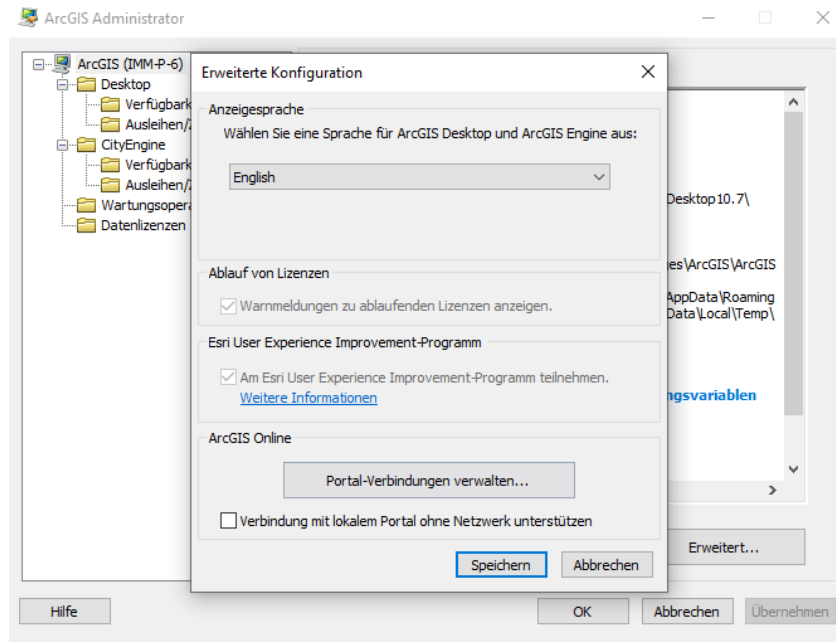

Figure 8: ArcGis Administrator.

Subsequently, the link of the place where it is wanted to publish the data should be added, in this case the Geoportal link will be trusted: (https://www.imm.hs-karlsruhe.de/geoportal/home/) as it can see in the following image. (Figure 9).
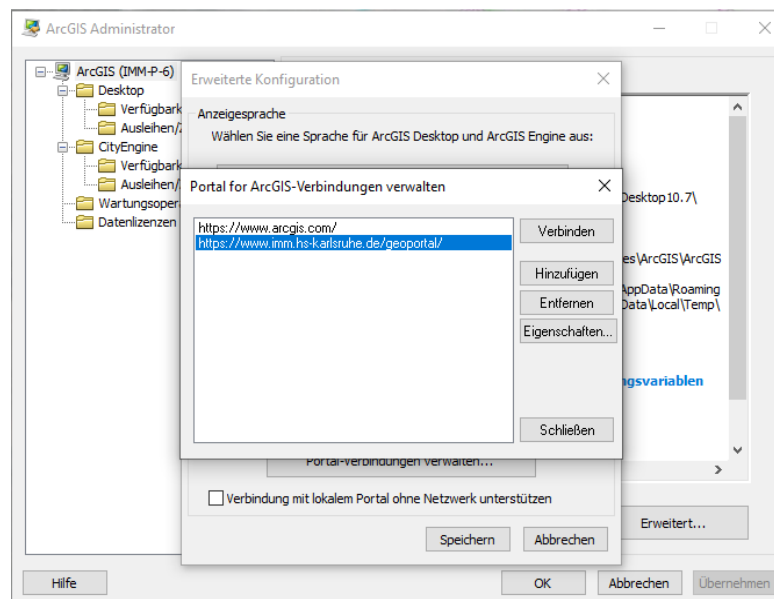

Figure 9: Choose the URL in ArcGis Administrator.

When the link has already been configured in ArcGIS administrator, the next step is to go to ArcMap, open the Dataser that it is wanted to publish. Subsequently, from the main menu (as can be seen in the image 10) it is necessary to log in with the username and password used to enter the Geoportal. As it can be seen, from ArcMap, at thetime to log in, the name of the Geoportal already appears, becouse it was previously configured from ArcGIS Administrator.

Figure 10: Log in ArcGis.

The next step to follow, select the "Share As" option and the "Service" option as can be seen in the following image (Figure 11).
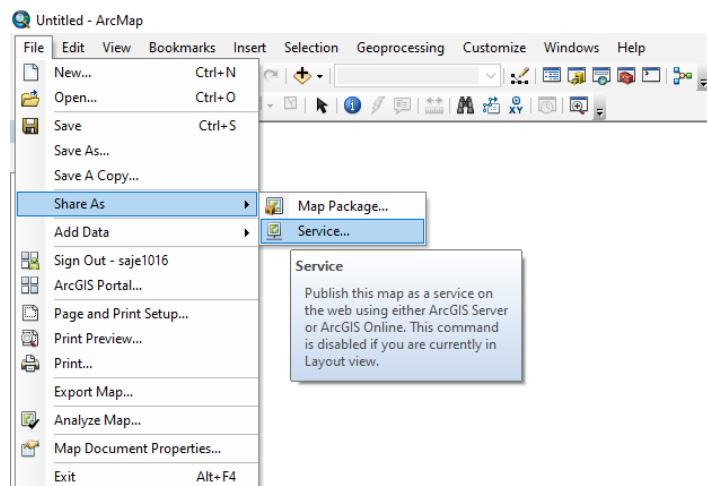

Figure 11: Share Service in ArcMap.

Selecting this option will allow the Dataset that is being displayed in ArcMap to be published on the website previously assigned in ArcGIS Administrator.

But to finish it is necessary to configure and revise some parameters. A new window will appear (Figure 12) that will have four different sections (Parameters, Capabilities, Item Description and Sharing). It is possible to leave all the values as they are, except for the Item "Description" section. (The information about the data we want to publish (metadata), and the "sharing" section, where we will indicate with whom you want to share the data). (e.g. All geoportal, some group or only in my content).
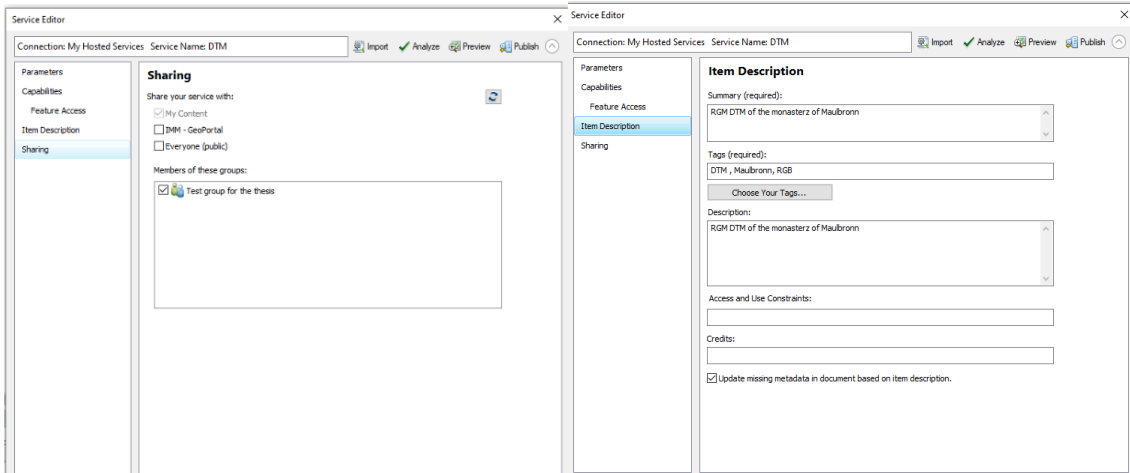

Figure 12: Parameters to share the data.

- **From the Geoportal**: data can also be published, but it must be data that is not hosted layers. For example, a video or a photograph (Figure 13).

  The first step is to go to the "My content" section and click on the "Add item", then select "My computer" option.
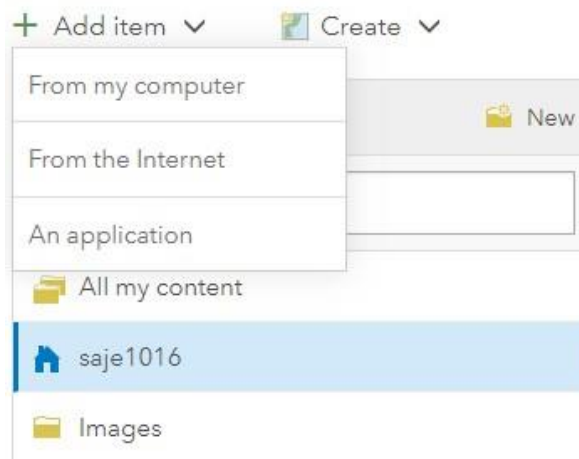

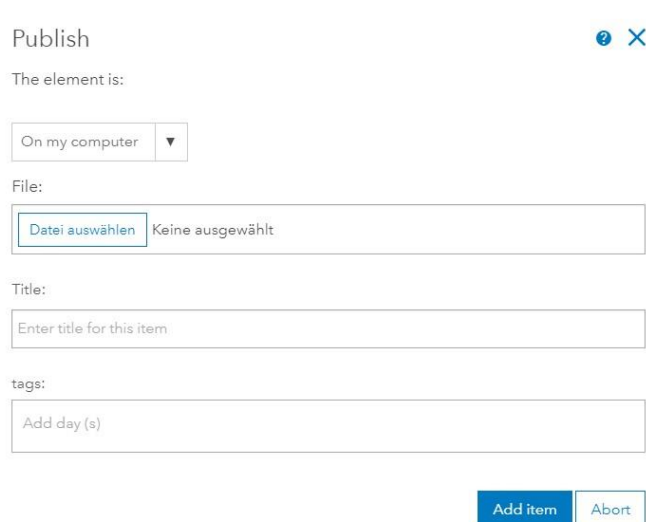*Figure 13: Share data from the Geopotal.*

Figure 14: Form to publish the data.

5.2 Geoportal Server

5.2.1 What is Geoportal Server?

Geoportal Server is a free, open source ESRI product. It has an Apache 2.0 license, which allows to access the Source Code, download it from GitHub and edit it to the user's liking.

It is a search engine for spatial resources, allows users to search different geospatial resources based on different issues and filters (by text, by map extension, by date, etc.) In addition, it has more features such as managing, publishing and storing metadata (it was its first functionality) or downloading services.

Using this Software to create a Geoportal in which it is wanted to include a lot of data it could be useful because when a service is published it must fill in determinate metadata such as title, description, keywords, location, date of creation, institution that has done, etc. These metadata help when a user wants to carry out a search, it is much easier to find the data that the user is looking for. Moreover, following the metadata standards, it also managed not to have repeated data.

5.2.2 Parts

As it mentioned before, Geoportal Server is an application that must be downloaded and installed on our computer in order to modify it and start working. But on the Internet, ArcGIS has published the application so that users can get an idea of how it works and how to do it and be able to make some tests.

The application can be divided into different parts (Search, browser and administration):

❖ <u>Search</u>. In this part you can search for services in different ways:

- By keyword: in the box at the top, it is possible to write a word and show all the results in which the metadata includes the word we have searched for.

- It is possible to select in which web sites you want to search, only in the Geoportal or select one more that is configured.
- By the type of content (Document, images, maps, etc.).
- Category of data (Agriculture, cadastre, elevation, society, etc.).
- It is possible to sort the results by different criteria (Relevance, by type of data, by date, etc.).
- By date: putting a range of dates so that only appear included on that date.
- You can also perform a search on the map, you can zoom in on a certain area and mark the option that only shows results in that area.

Independently of the type of search (it is possible also to combine the different types of search) on the right will appear all the results of services published in the Geoportal that fits these search criteria. Also, by clicking on one of the results, different options will be obtained:

- Open.
- Preview.
- Add to the map: it is added in a map, which by default is a map of ArcGIS Online.
- See details.
- See metadata.

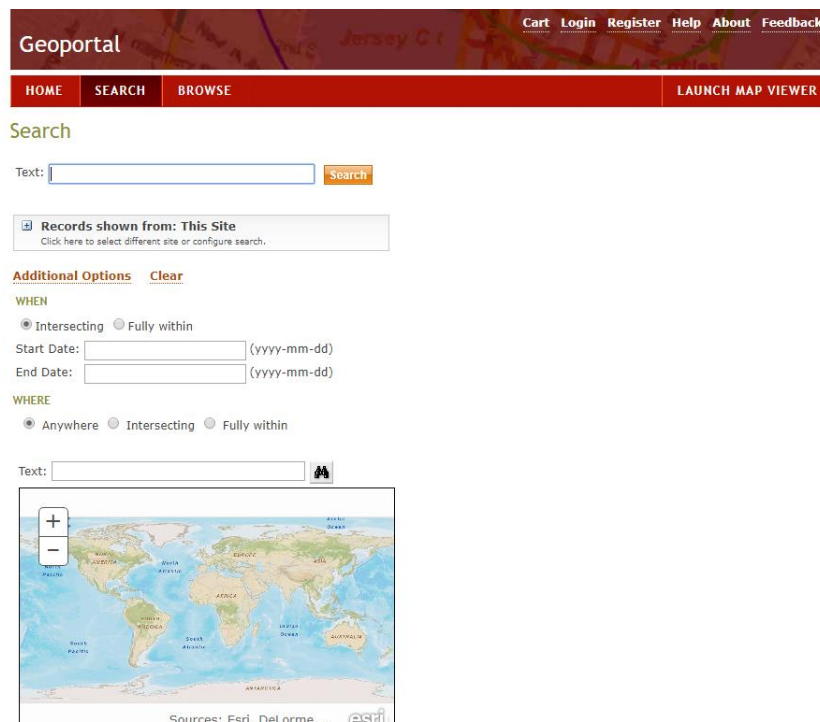In the following image you can see the interface of this section:

Figure 15: Geoportal Server Search.

❖ <u>Browser.</u> In this part it is possible to navigate among all the content that has the Geoportal. Here the user can see all the content organized by categories, in this section it can also search by keyword so that only the results appear with that word.
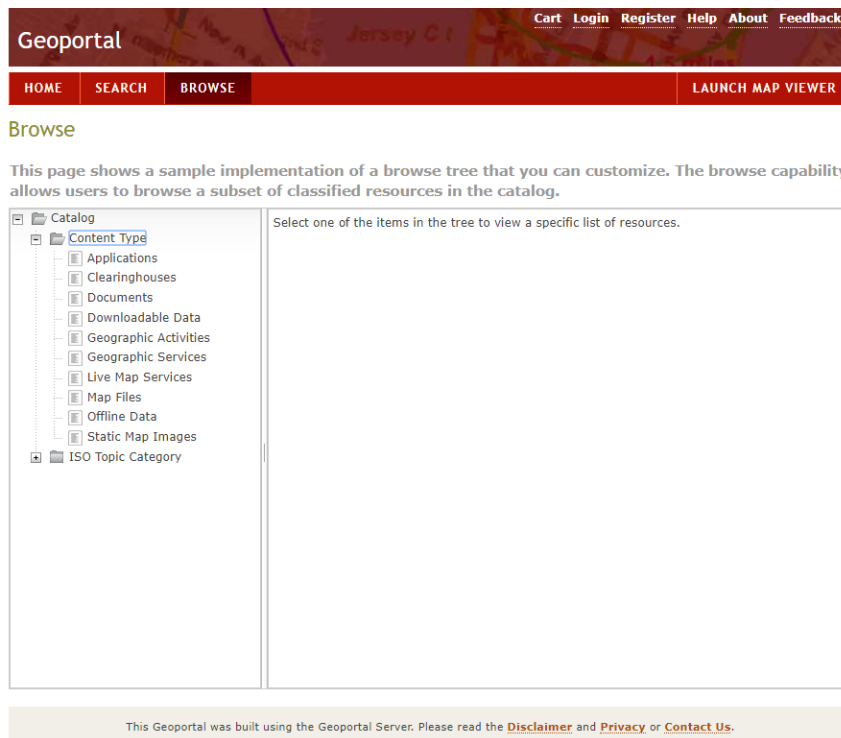
Figure 16: Geoportal Server Browse.

❖ <u>Administration</u>. This option is only available if the user enters its username and password. Integrates a security model with xml files.

In this part it is possible to manage and publish all the data in the Geoportal, there are three publishing options:

- Register resource on the network: this option will be the most used for this project, based on a URL. From this option it is possible to publish a service that is published on a server. For example, by clicking on the "URL" option the user can publish an ArcGIS Server service. By clicking on "ArcGIS", it is possible to publish a whole folder or an instance of ArcGIS Server.
- Upload metadata file from the local disk: with this option it is possible to publish a metadata file that already have created.
- Use dedicated editor to create metadata manually: with this last option the user can create a metadata file from the beginning, a form will appear to fill in data and metadata validations will be done according to the standards.

Geoportal Server does not save the data. When the publisher wants to publish an ArcGIS Server data, for example, a simply save the registry, the metadata and the access form so that when the user searches for that element, they put it in contact with the server and work with that URL.

Another interesting option that Geoportal Server has when publishing a service is that it can indicate how often you want the service to be reviewed, and it can mark it as an option to send an email to the administrator of the platform, indicating if one of the services has been eliminated or modified.
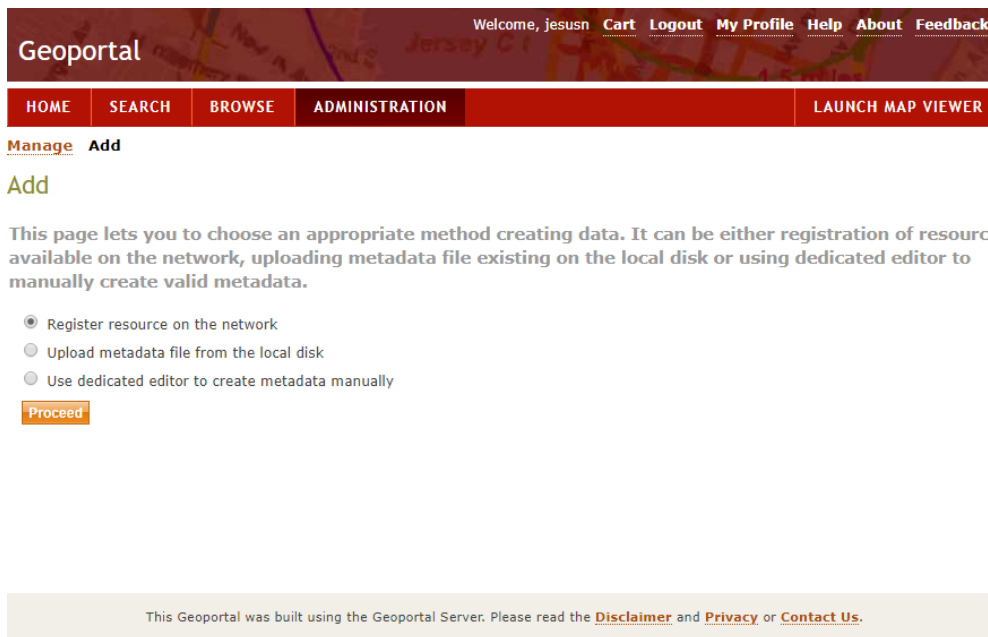
Figure 17: Geoportal Server Administrator.

❖ <u>Map</u>. In addition, Geoportal Server has a map where the user can add and visualize data; this map is made with ArcGIS Online. It has a series of basic tools, but it is possible to add all the tools that it is wanted or needed.
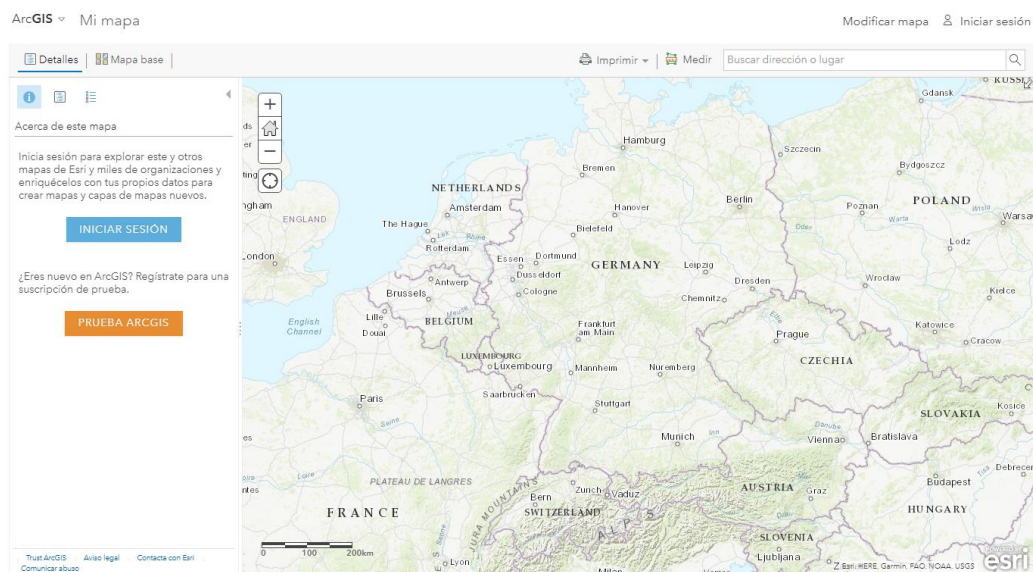

Figure 18: Geoportal Server Map.

5.2.3 Extensions (Geoportal Genie)

Geoportal Server has an extension called "Geoportal Genie". It was created to make Geoportal Server have a more user-friendly interface. It is a more modern application so it is developed with HTML5 and CSS3, this means that it will work well in all browsers and will be easy to edit.

The interface looks like that:
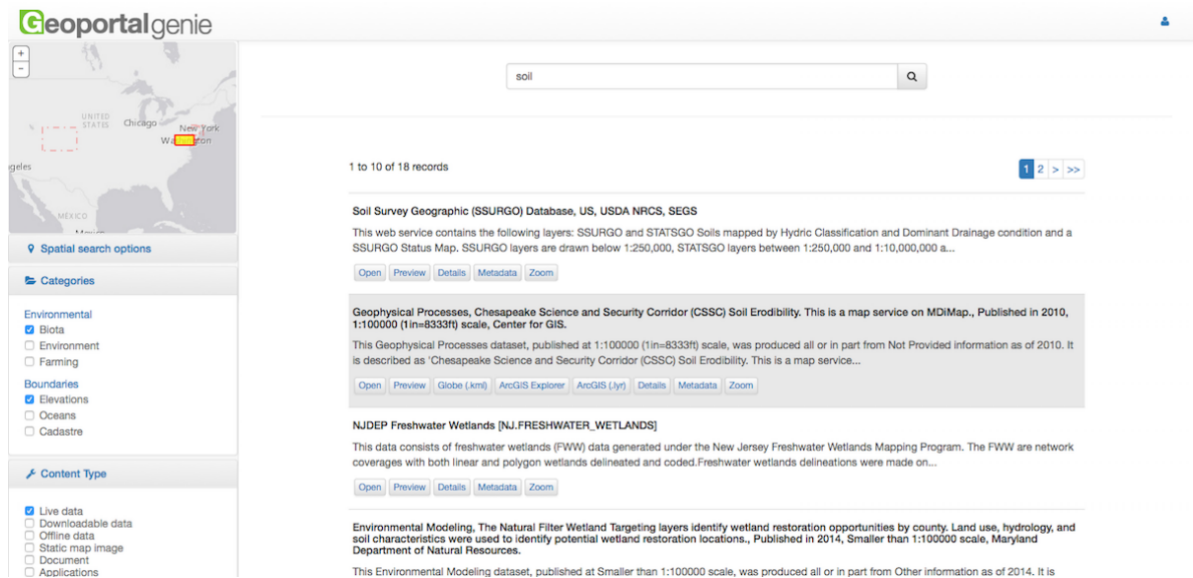
Figure 19: Geoportal Genie.

Taking in account this picture it can see that it has an interface similar to Geoportal Server, but the search engine is on the left and is structured differently. The options to carry out the search are: by extension of the map, by categories, by the type of the content and by the date range.

In addition, there are small variations like the one that can be seen in the following image. When it is wanted to see the information of a service, with Geoportal Server another new tab is opened in our browser. In the case of Geoportal Genie, a pop-up window opens with the information.

Figure 20: Geoportal Genie.

5.2.4 Download and install

In order to install Geoportal Server, certain requirements must be taken into account:
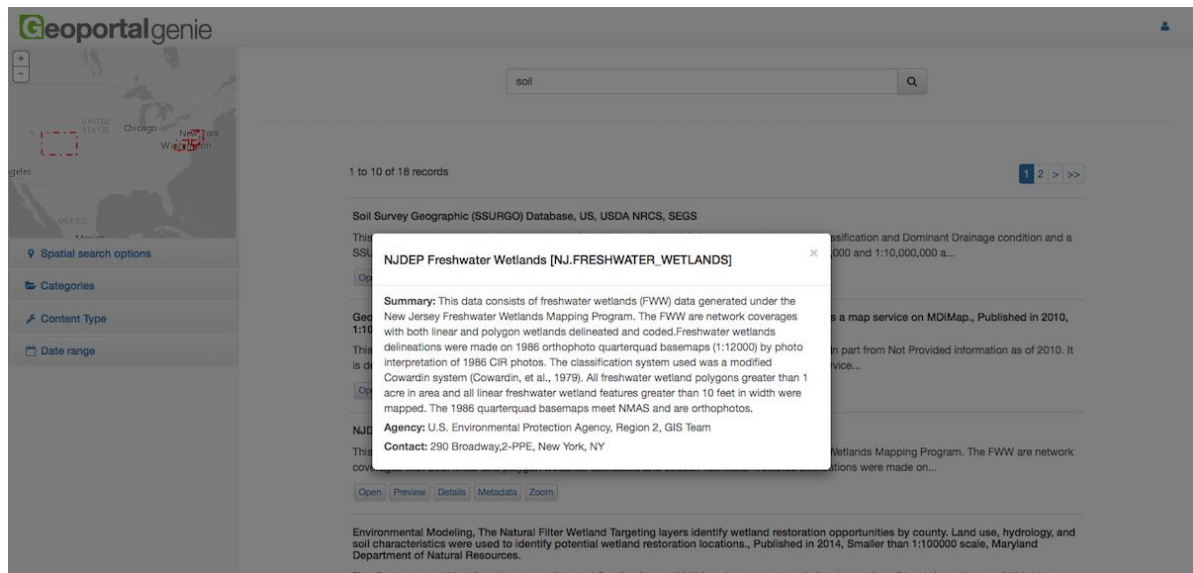
- Have an operating system (Windows or Linux).
- Have a database that we must subsequently implement on the server where the web application is (Oracle, PostgreSQL, Microsoft SQL Server or MySQL).
- Java.
- Apache Tomcat.
- A map services.
- Esri JavaScript API.

When those requirements are known, it is necessary to move on to the installation and configuration. The following steps are different depending on the operating system that it has. In this case it will be explained for the Windows operating system:

- **Configure the Geoportal database**. Geoportal Server requires a database to store information and content (such as metadata). In the files that are downloaded, there are database scripts that must be executed to create a default schema. Depending on the database chosen, it will be done in one way or another.

- **Implement and configure the Geoportal web application in Tomcat**. This is done in order to see the geoportal in a web browser through a local server. To have detailed information on how to configure Tomcat.

- **Smoke tests of the Geoportal**. In this part we will do a test before continuing with the installation, it will be verified if the geoportal is in operation.

- **Configure a directory server for the Geoportal.**

- **Advanced configurations for Geoportal.** For this step we must locate the file "gpt.xml" there are different configurations.

- **Install desktop tools**. There are different tools like (Geoportal csw client, published in geoportal client, client wmc, etc).

After installing Geoportal Server, it is recommended to perform the following steps:

- Customize the User Interface for your Organization's Look and Feel
- Modify Default Usernames and Passwords.
- Schedule Synchronization.
- Register the Geoportal Sitemap with Search Engines.

5.2.5 Texting

After downloading, installing and configuring the Geoportal Server, the following results are obtained (Figure 21).
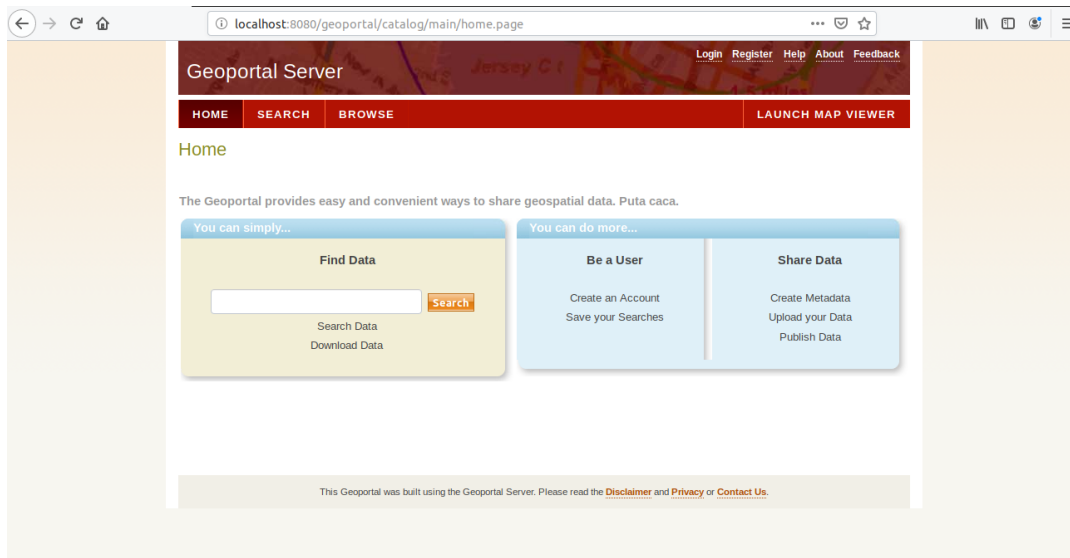
Figure 21: Geoportal Server.

Subsequently, different tasks have been performed:

❖ The first step is to configure the username and password of the platform administrator. It is the only user control that Geoportal server has implemented. In addition, it can also be created another general user control to manage all users, the problem with the latter is that it is not implemented, it should be implemented with programming.

❖ Subsequently, data have been published to test, it should be remembered that Geoportal Server also uses "ArcGIS Server" as a database.

❖ In addition, different tests are performed to change the style of the platform since, in the case that this is the option chosen, several things should be modified.

In the following image it can see the code that has been changed to get the Geoportal Server title changed.

Figure 22: Code to modify the Geoportal.

In the following image it can see how the title has been modified. Before it put Geoportal Server as you could see in the figure 21, and now the title is Maulbronn as it can see in the next image (Figure 23).
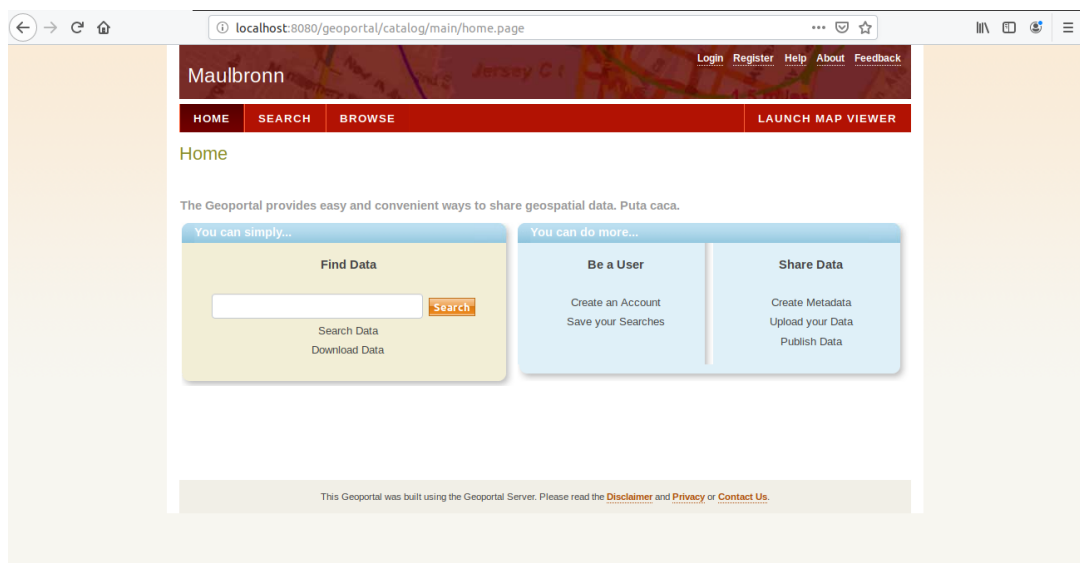

Figure 23: Geoportal Server modified.

5.3 Perform it from scratch.

Made with web programming: when a Geoportal is made without using any platform already created, tools, framework or applications are used to facilitate the work. The tools that have been used to carry out the previous Geoportals will be explained.

Store the data:
- **Geoserver:** It is a resource server, stores the location of the resources that you want to publish in the Geoportal and allows the user to view them in the Geoportal.
- **PostgreSQL:** it is a database where resources are stored.

Create a map:
- **Open Layer or Leaflet:** This are JavaScript Api, of free software, that allow maps to be made easily and free of charge.

Metadata
- **Geonetwork:** it is a catalog of metadata, it is used to help make the metadata of the data published in the Geoportal and helps to locate them more easily.

Programming languages:
- **HTML:** is the standard mark-up language for Web pages.
- **CSS:** is a graphic design language to define and create the presentation of a structured document written in a mark-up language.
- **JavaScript:** it is a programming language that allows you to create actions on web pages.

6. Comparison Software

In this section, tables will be made to analyse the three options.

6.1 General features

Performing a Geoportal with a platform already created has the great advantage that it would already have the Geoportal created, it would only have to configure the application and publish the data that would like to display in the Geoportal. On the other hand, by creating the Geoportal with web programming, the problem is that is has to be to developed everything from the beginning, which makes the work larger and more complex.

Following with the analysis, we also find a disadvantage if we do the geoportal with already created application, and an advantage in developing it from the beginning. The disadvantage is that the application already has a design created, having to settle for that design, those functions and those tools. By developing the Geoportal from the beginning, we can make the design we want and add the tools it is wanted.

A more detailed analysis will be done to obtain more conclusions.

All Geoportals made with web programming will be grouped in the same category because for the purposes of this analysis the result would be the same, they would all have the same characteristics.

In the following table, this can be analysed in more detail:

	Geoportal Server	Portal for ArcGIS	Starting over with web programming
Free	x		x
Open source	x		x
Modern interface		x	x
Easy to use	x	x	x
Create a Geoportal quickly	x	x	
Accessible for the user	x	x	x

As it can see in the previous table, make a Geoportal starting with web programming to be one of the most appropriate options, but it has the problem that the Geoportal cannot be created quickly.

If it is wanted to make a Geoportal from the beginning and without using any application already created or some complement that reduces the time of realization, the work can last many months. Depending on the tools and functionalities that it is wanted to implement, the time could be much greater than by performing the Geoportal. For example, with Geoportal Server or Portal for ArcGIS, in addition, it would be necessary to have very high knowledge of programming in different programming languages.

Geoportal Server has the problem that the interface is not modern, but that should not be the big problem since Geoportal Server is a free license application as mentioned above. Besides when performing a Geoportal, we can edit the code to try to give a more modern and improved look. The problem with that is that it would be more time and more work.

Portal for ArcGIS has the problem that it is not free software, which would cause an unnecessary cost to perform a Geoportal since we have seen that it can be done perfectly with other Free Software tools. But this is not a problem for us because the Faculty of Information Management and Media has a licensed and we would have no additional cost, but it is a fact that must be known in order to better analyse the Software and for future projects.

Another problem that it could be found is that it is not an open code application, so it is not possible to edit the application freely. But to counteract this problem, Portal for ArcGIS has the option of developing tools and functions with "Web App Builder for Developers" which allows the user to primarily customize their applications.

With this analysis it can begin to have the first conclusions, but it must continue with the analysis to obtain better results.

6.2 Functions

In this chapter it will be analysed the functions that Geoportal Server and Portal for ArcGIS have, in order to choose the best option for the project.

In this section it will not analyse making a Geoportal without using a platform because it is not necessary. Starting from the beginning, it is not possible analyse the functionalities that it would have or not since it could have all that the developer wants to implement. For the final conclusion, it will continue to take it into account.

	Geoportal Server	Portal for ArcGIS
Search data by filters	x	x
Download the data		x
User Control		x
Map	x	x
Catalog of data	x	x

Portal for ArcGIS is an application designed mainly to create maps and share them with people of your own company or organization. In the following years, Portal for ArcGIS was improved following the needs of users

Geoportal Server has always had the same functionality and objectives, being a catalog of data stored and classified by metadata, where the user can search for that data using different parameters (keyword, data type, date, etc.). Also, it is possible to visualize that data, see details, add to the map, etc.

Now the functions of the previous table will be analysed in detail.

User control

Portal for ArcGIS and Geoportal Server allow to have a control of users with a "Log in". But actually, they are very different, so for that reason, they will be explained below.

In Geoportal Server, the log in function is already implemented, but it is needed to configure it to choose what type of authentication it is wanted:

> - Simple authentication: Provide only one user, who will be the administrator who will publish the data and manage the geoportal.

> - LDAP authentication: requires a special configuration, but it has the possibility of creating users, and when logging in they have more privileges than users who are not registered. The problem with this option is that it would have to be configured and added with web programming. Which would take time to configure.

Portal for ArcGIS also has user control, it allows everyone to access to the geoportal. But there are certain parts to which only logged users have access. In addition, a publisher can decide with which users he wants to share the data to be uploaded. It is also much more complete, each person can publish data and select with which users they want to share it, so it is possible to publish data so that all users can view it, data so that only registered users can see it, or data that only the users that the publisher has chosen can see.

For this reason, Portal for ArcGis is better for user control since it is much more complete and is already implemented and ready to use.

6.3 Conclusion of the comparison

To sum up all the solutions are a good option for a Geoportal, but each of the options has its advantages and disadvantages.

Performing a Geoportal with Portal for ArcGIS is a very good option since it is a tool that is improving day by day. In addition, it has a very modern interface and the Geoportal has a multitude options as has been mentioned in the previous chapters.

It can be seen that there are many articles and projects that highlight the Geoportal Server Software with respect to others, for example, the article (Lanz, 2011) analyses which are the best Software that use metadata and this is the result:

The article (Lanz, 2011) makes a comparison of Softwares to work with metadata. This article talks about Geoportal Server and GeoNetwork.The comparison is based on a literature review, extended by user forum discussions and expert input.

Performing a Geoportal by hand is also a very good option, in addition it can see that most Geoportals are made without using any platform. But this is because when it is wanted to make a Geoportal, do not find a platform already created that satisfies the needs they have for the Geoportal, and that's why it is done with Web programming.

But by comparing this option with Geoportal server or with Portal for ArcGis, it can conclude that it is better to do it with any of the previous applications since they are two very complete solutions that have all or almost all the functions that this geoportal should have.

Therefore, the option to do it without a platform is going to be ruled out. The analysis will focus on the other two options mentioned above.

After the two previous analyses, it is still difficult to conclude that Software is better for the purpose of this project.

As for the general analysis, it can be seen that both options are very similar, the only problem that Portal for ArcGis had was that it is paid, but as mentioned earlier, that is not a problem since there are licenses in the faculty. Geoportal Server has the problem that it does not have a modern interface, it was commented that it can be fixed with Web programming, but that has a problem:

Geoportal Server is programmed with JSP (Java Server Pages) language, this is a disadvantage, this is because it is a complex programming language. JSP is a way to make Web pages with the Java language, that way it allows to use many classes to make powerful tools and those tools will be called through classes.

This makes the editing of the code more complex than if the application was created with Web programming (HTML, CSS and JavaScript).

Then, it can be seen that in general terms, Portal for ArcGis is better since the only problem was the cost and it is solved, and the Geoportal Server problem is more difficult to solve.

Now the function comparison is going to be analysed. With this comparison the final decision is clearer, you can see that Portal for ArcGis has all the options that the geoportal should have, and in turn, Geoportal Server does not have them all, it should be configured or added different functions such as the control Full user or data download options.

For all this it can be concluded that Portal for ArcGis is the best option to create the Geoportal, it is an already created tool, which would facilitate the process of making the Geoportal. In addition, seeing the previous analyses, Portal for ArcGis has all the functions that our Geoportal should have, and if at any time a new tool or function is needed, Web AppBuilder for Developers can be used, which allows you to create Widget easily.

7. Solution with Portal for ArcGIS

As it can see in the previous chapter (Chapter 6), Portal for ArcGIS is the most optimal option to carry out this project. So, it will be the option that will be used to create the Portal. Next, the process followed in order to obtain the final result will be explained step by step.

7.1 Configuration

First of all, to start working it is important to have a place to store the data, information and the final result of the map application. For this the group that was created previously when they were having texting will be used. The group will be called Maulbronn. In addition, a brief information about the project will appear in the group and the information will be classified in folders.
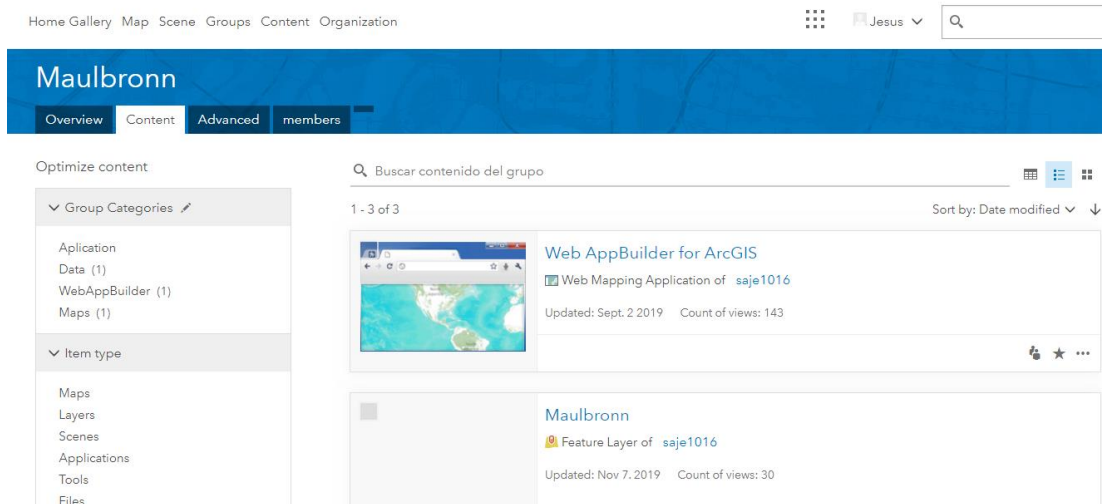
Figure 24: Portal for ArcGis group.

Storing the data and the final result in the group is intended to ensure that this information is only accessible to users in the group, and only users who receive an invitation will have access to the group. In this way, not everyone can see and edit the data and the application.

The next steps will be to publish the data and start to make and configure the map that will be the basis of the final application.

7.2 Publishing the data

As it can see in chapter 5.2.3, data can be published in two different ways, depending on the type of data (from the Portal or from ArcMap), apparently it should be the most optimal option and the option chosen. But after analysing how the final result would be (functions, data structure, etc.), it has been concluded that, if published in the manner discussed above, the data cannot be searched on the map (by extension) and also it would be more complex to configure the download part. These two functions would be a very important part for this project, so it has been thought to publish the data in the Geoportal differently. The data will be published in a local university space, called Webserver.

The Webserver is a local "Hochschule Karlsruhe - Technik und Wirtschaft" Webspace where it is possible to store data and later view and / or download it in an automatically generated URL that can be viewed on the internet.

To access the folder where to store the data, it is necessary to access it from a university computer or via VPN connection. The path to be written in the Windows file explorer must be:

\\imm-gisweb.hs-karlsruhe.de\saje1016

For each student or professor of the University it is possible to create its own folder to store data. The last part of the link (saje1016) corresponds to the name of the folder, which in this case corresponds to the username. To access the information published on the WebServer, it schould be accessed it from the Internet through the url:

https://www.imm.hs-karlsruhe.de/intern/dev/saje1016/

With the previous path, the folder with all the data will be displayed (figure 25), and from the browser it can be chosen the folder and clicked on the data that it is wanted to see, but if at the end of the route the full name is named of a complete data (https://www.imm.hs-karlsruhe.de/intern/dev/saje1016/Maps/Beilage1_Kloster.jpg) the map will be displayed exclusively whose title is: "Beilage1_kloster.jpg". Here it is possible to see an example (Figure 26).

imm-gisweb.hs-karlsruhe.de - /dev/saje1016/

[To Parent Directory]

05.08.2019	15:32	\<dir\>	CAD
05.09.2019	15:54	\<dir\>	Documents
05.09.2019	16:06	\<dir\>	Images
05.09.2019	15:54	\<dir\>	Maps
05.08.2019	15:41	\<dir\>	PointCloud
09.10.2019	16:32	\<dir\>	Shapefile
05.09.2019	16:12	\<dir\>	Shp
09.10.2019	16:12	\<dir\>	Thumbnails
16.09.2019	13:27	\<dir\>	Video

Figure 25: Data in the Webserver.
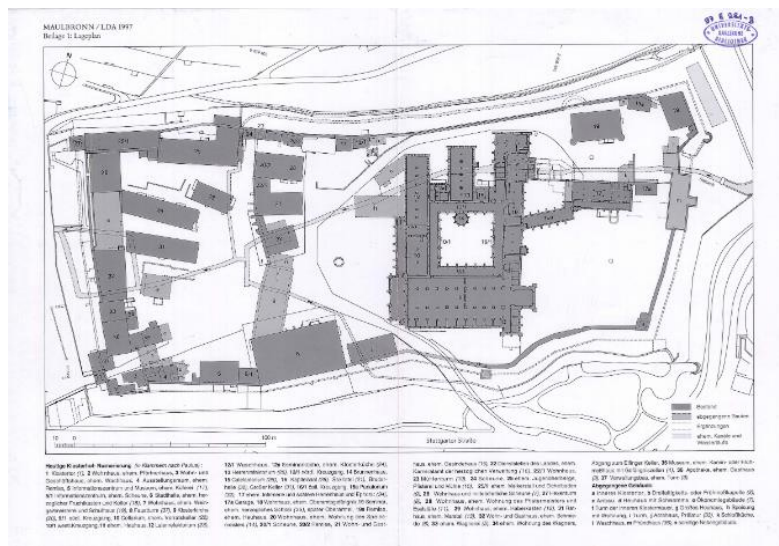
Figure 26: Old map.

The choice of this way of publishing the data is because a large amount of data can be published easily and quickly. The files that can be opened without the need for a secondary program (such as images, maps, videos, etc.) will be published without any modification. So that the data that needs to be can be displayed on the computer with just one click open in a program such as AutoCAD or ArcMap (CAD data, DTM, etc.) will be published in a ZIP.

As seen in the previous photo (Figure 25) a logical folder structure has been created so that the data is organized. In addition, there are subfolders within a folder. The idea that the data is well organized, this will help the subsequent processes of assigning the Link to the data and be able to work in an orderly and easier way when you have a large amount of published data.

Folder structure:

- **CAD**: For AutoCad data
- **Documents:** All types of documents that have a relationship with the monastery as for example thesis of previous years or works (PDF, Word, etc.).
- I**mages**: this folder is subdivided into more subfolders so that the images are well classified.
  - o **Aereal Images**: Aerial images and orthophotos of different years can be found.
  - o **DTM**: Digital Terrestrial Model, here you can find DTM in both IR and RGB.
  - o **General Images**: photographs taken from different parts of the monastery.
  - o **Maps**: maps of the monastery (both old and current).
- **Shp**: Shapefiles.
- **Thumbnails**: This folder is destined to save the thumbnails that it is wanted to be displayed in the Geoportal in the attribute table.
- **Video**: here you can find the videos that will be published on the Portal.

The next step will be to create a Shapefile where the extension of the data to be published will be digitized. In such a way that the shapefile can be visualized on the Portal map, the extension of the data can be seen, and they can be easily interpreted. Since Each type of data will have a different colour and you will also have the option to perform specific searches using Widget with the intention of facilitating the location of the data.

In addition, the attribute table of the Shapefile layer created to include each of its records will be edited, and also the link of the data that will be published in the web server will be included as explained above, that way They will be able to visualize data in the Portal, through the metadata it will be possible to see which one is the most suitable for the user and finally they will be able to visualize and download the data easily through the Webserver (link that will be included in the table of attributes).

7.3 New Shapefile

As mentioned above, the map is easy to use, it has interesting functionalities for this work, and so that the user can easily find the data that is useful for him. The user will proceed to create a Shapefile where the extensions of all the data will be digitized, then the attribute table will be filled in with the most relevant information of that data (metadata).

Although to do this correctly, it is necessary to create the layer in a geodatabase to be able to add domains that will later see what its objective is.

7.3.1 Create the Geodatabase

First, before creating the new layer, a Geodatabase must be created. This is necessary to be able to create domains in the database as explained above, later the layer will be created within the database and those domains created can be assigned to the fields of the layer.

It will be created in ArcGIS, specifically in ArcCatalog.

7.3.2 Create domains

Before starting to create domains, it is important to be clear about what they are and what they are for:

Attribute domains are rules that describe the legal values of a field type. They provide a method to force data integrity. Attribute domains are used to limit the values allowed in any particular attribute of a table or feature class" (Un recorrido rápido por los dominios de atributo—ArcGIS Help | ArcGIS Desktop, no date)

As mentioned in previous chapter, in the layer to be created, the attribute table will be filled with data information. Three domains will be created to get the data published more easily and no error. The three domains are:

- Type: A domain has been created so that when completing the "Type" field. A Drop-down appears with all the options of all types of data. In this way it allows that there is no error in the choice and that the name of the data type is correct (Figure 27).
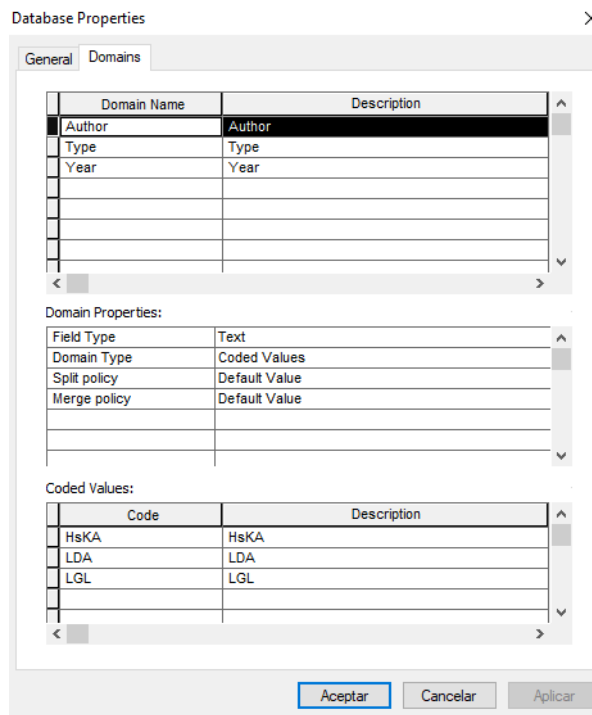
Figure 27: Different domains.

- Author: this domain is created for the "Author" field. The objective of this domain is the same as in the previous domain, but in this case, the domain will be for all Authors to create the data to appear (Figure 28).
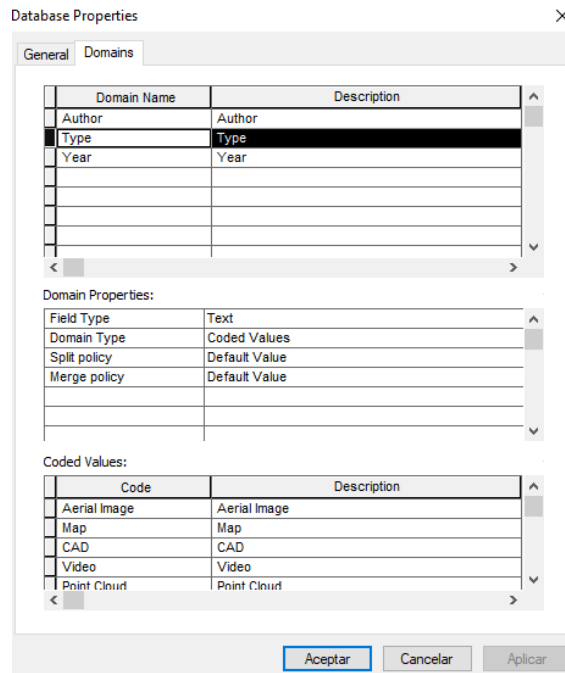
Figure 28: Type domain.

- Year: this last domain will be for the "Year" field, and its objective is that when a user wants to fill in the year of a new record. Only number type data can be placed in that hole. Also, a restriction is placed so that the year is between 1000 and 2100, that way the user can know that the number that the user enters is in the correct format (Figure 29).
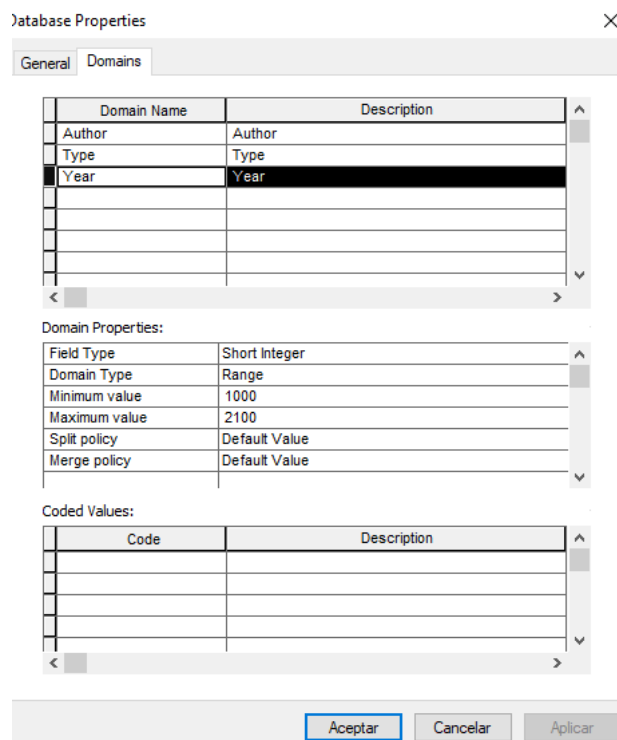
Figure 29: Year domain.

7.3.3 Create the New layer

To carry out these tasks, ArcGis Software will be used.

The layer can be created of type points, polygons, lines or polylines. But in our case the polylines option has been chosen. Since after performing different tests, it has been chosen to perform it of this type because, if it is made of a polygon type, there will be polygons that overlap over others, and that way it is more complicated to click on the polygons that remain at the bottom of the map. Making the layer of Polyline type, the appearance of the layer will be the same, but it will have the advantage of being able to easily select all polygons. Although there is also the disadvantage that to select a data, the user can only click on the edge of the extension (on the line that draws the extension).

In addition, a reference system must be assigned to the created layer. This is very important so that the data is displayed in the right place with the coordinates and projection correct.

The system has been chosen: *DHDN_3_Degree_Gauss_Zone_3*, it is used for this project. In addition, the other data that it is wanted to visualize on the map have the same reference system.

The characteristics of the reference system are:

Unit: metre

Geodetic CRS: DHDN

Datum: Deutsches Hauptdreiecksnetz

Ellipsoid: Bessel 1841

Prime meridian: Greenwich

Data source: OGP

Zone: 3

When the layer is already created and with its perfectly defined coordinate system, the next step will be to digitize the extension of the data.

7.3.4 Digitize

As mentioned above, so that the user can search for data more easily on the map, it will be important that the extent of each of the data is digitized. To do this, first, a WMS (Web Map Service) connection is made from ArcMap to load an orthophoto as a base layer to digitize on that (Figure 30).
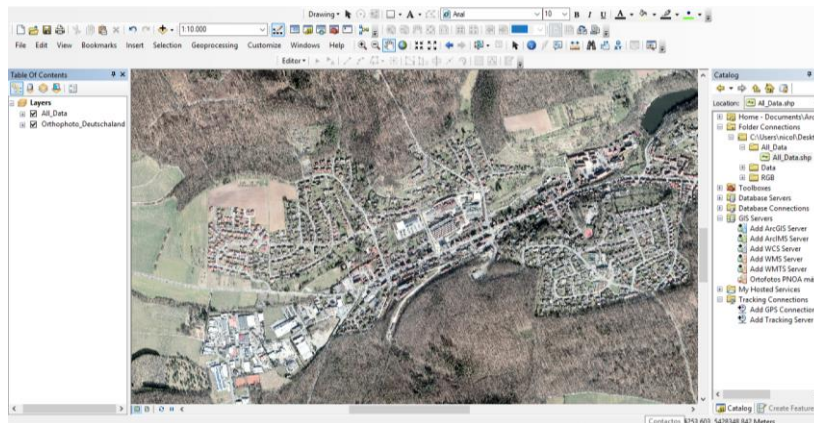
Figure 30: Orthophoto to digitalize the new layer.

First, the edition of the layer that it is wanted to digitize must be activated (Figure 31) and everything will be ready to start the digitize tasks.
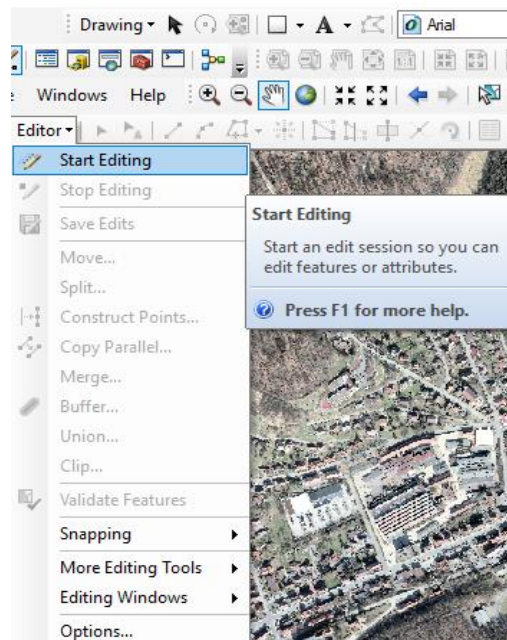
Figure 31: Start editing in ArcMap.

The following process is different depending on the type of data you want to digitize:

- The data that can be opened by the ArcMap and have an assigned coordinate system. For example, DTMs. It is the easiest way to digitize since that data will be displayed in ArcMap. It is superimposed on top of the Orthophoto and just in the place where the extension corresponds it is digitized manually following the edges of the data that has been opened.
- The data that it cannot be open in ArcMap or that have no coordinate system assigned, for example, an old map or a document. The process followed to digitize this type of data is different, the data will be opened, and it will be digitized using the photointerpretation technique. Seeing the data, it will be interpreted on the orthophoto which is the extension to which each of the data corresponds.

To start scanning, the user has to click on the point where it is wanted to start. Also, from that point the user clicks on different points thus drawing the extension of the data that it is wanted to digitize, between a point and a point a line will be created. It must be finished

by double clicking on the first point since it will remain like a polygon and the extension of the data is perfectly defined with a polygon.
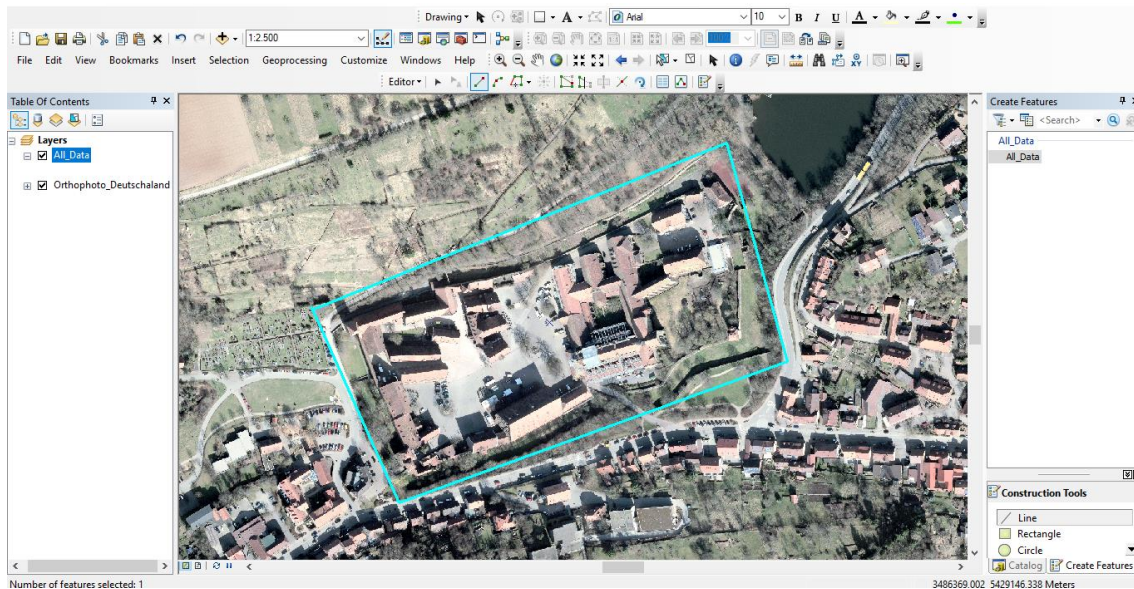
Figure 32: Digitalizing the data.

Each digitized polygon will have different row in the attribute table and will belong to a different data.

7.3.5   Attribute table

The next step that will be carried out will be to add different fields to the attribute table with the intention that each of the data has metadata that can later be displayed in the Geoportal.

It is necessary to add as many columns as metadata that want to be added to the table (year, author, etc.) (Figure 33).

The fields created are:

- **Title**: It is important since using this information we can know what data it is and have a general idea.
- **Type**: there are different digitized data, that has been classified by type. This field will also be important for the Widget and for the legend.
- **Year**: in this field the year in which the data was created will appear.
- **Link**: in each of the data a link will appear where to view / download that data. The link will correspond to the Webserver explained above.
- **Author**: Here, it will be defined that user has created the data to published. In this case we have three different kind of authors:
    - LDA
    - LGL
    - HsKA
- **Thumbnail**: Here another Webserver link will be placed and it will be a screenshot of each of the data. That is, each data will be assigned in miniature. This link will be used later so that in the table that is displayed in the Geopotal,

a thumbnail of the data appears, and we can see in small to what each data corresponds without opening or downloading it.

Figure 33: Atribute table.

When all these steps are done, the next is to publish all this information in the Geoportal to have it available to create the map and the application.

7.4 Web AppBuilder for Developers

Web AppBuilder for Developers is an application to create custom widgets and themes. That Boost your productivity by extending the framework. Build powerful GIS apps that run on desktops, tablets, and smartphones.

Web AppBuilder for ArcGIS was developed using ArcGIS API for JavaScript and HTML5 technology. It is an app included with your ArcGIS Online organization and Portal for ArcGIS.

There is the possibility to create and deploy custom mapping apps using Web AppBuilder for ArcGIS Developer Edition. It can be download to the local machine, and it provides the same user experience as Web AppBuilder for ArcGIS in ArcGIS Online and Portal for ArcGIS. Some users choose to work with the developer edition because they want to extend the capabilities of Web AppBuilder for ArcGIS with custom widgets and themes, or they prefer to host their apps on their own web servers. There is a large and very active Web AppBuilder for ArcGIS user community on GeoNet that shares numerous custom widgets.

In summary, from Map for ArcGIS it is possible to obtain a map and use Web AppBuilder, but there is the option to download Web AppBuilder for Developers and make more elaborate maps using custom Widgets.

7.4.1 Advantages of Web AppBuilder

It is very important to talk about the advantages that Web AppBuilder gives us as opposed to doing it directly from Portal for ArcGis:

- It allows us to make more elaborate applications using Widget or custom templates. To work with the option of developers, knowledge of web programming (HTML, CSS and JavaScript) is required in addition to Node.js, but the results are always better since the solution or the widget can be programmed as the user wants.

- Widgets that are already created and come by default, in Web AppBuilder are updated and present improvements, while those in the Portal are not updated and do not present the new functions. For example, the "Filter" widget gives us the possibility to apply different search filters for a shapefile layer. If, in one of the filters, it is necessary to drop-down to appear with the options that it has in the database, one can configure it with Web AppBuilder for Developers, in the same geoportal widget. The user is the one who must Manually configure drop-down values.

7.4.2 Configure Web AppBuilder

- **Install:** first, it is necessary to download the Web AppBuilder for ArcGIS (Developers Edition) ZIP file in own local drive and unzip it.

  The Node.js must be installed on working computer since Web AppBuilder will run on it.

  To install it, open the previously unzipped folder and with double click on the file called "startup", start the Node.js server in the in the command prompt windows and Web AppBuilder for Developer in the default browser with a local URL.

- **Start Web AppBuilder:** the first thing to do is specify the URL of our portal, that is because to work with Web AppBuilder it is necessary to have an ArcGIS organization account.

Especifica la dirección URL de tu organización de ArcGIS Online o Portal for ArcGIS

https://www.imm.hs-karlsruhe.de/geoportal ✔

Proporciona el Id. de aplicación de Web AppBuilder registrado en el portal que has especificado arriba (Ayuda)

oOB7gawppVELgWKR

Continuar

Preguntas frecuentes

Figure 34: Start Web AppBuilder.

If it is the first time that Web AppBuilder is used with the portal specified above, the system asks for an application ID to support OAut2 authentication. Once, performing this step, it will not be necessary to repeat it again, and log in directly from the Portal.

Next, from the "Content" tab, click on "Add item" and select the option "An application" and fill in the data as in the following image (Figure 35).

Figure 35: Add the new application.

It is important to assign the correct URL, in that case is http: // localhost: 3344 / web AppBuilder. It is a local URL, where the assigned port is 3344, and the folder where the data is web AppBuilder. In addition, a title and tags must be included

- Generation of the code and validation of the application. To carry out this, one must go to the Portal, and search "Content" for the element that was created previously (Web AppBuilder). When the element will be typed, click on the "Advanced" tab, and the window will open with the information of the created application. Clicking the "Registration" button, will appear next information (Figure 36):

Figure 36: Parameters of the new application.

After replacing the URL, to start working with Web AppBuilder for Developers, one can register, and the needed ID will be generated. The code will appear just below the button where it has been clicked for the registration, as it is shown in following Figure37:
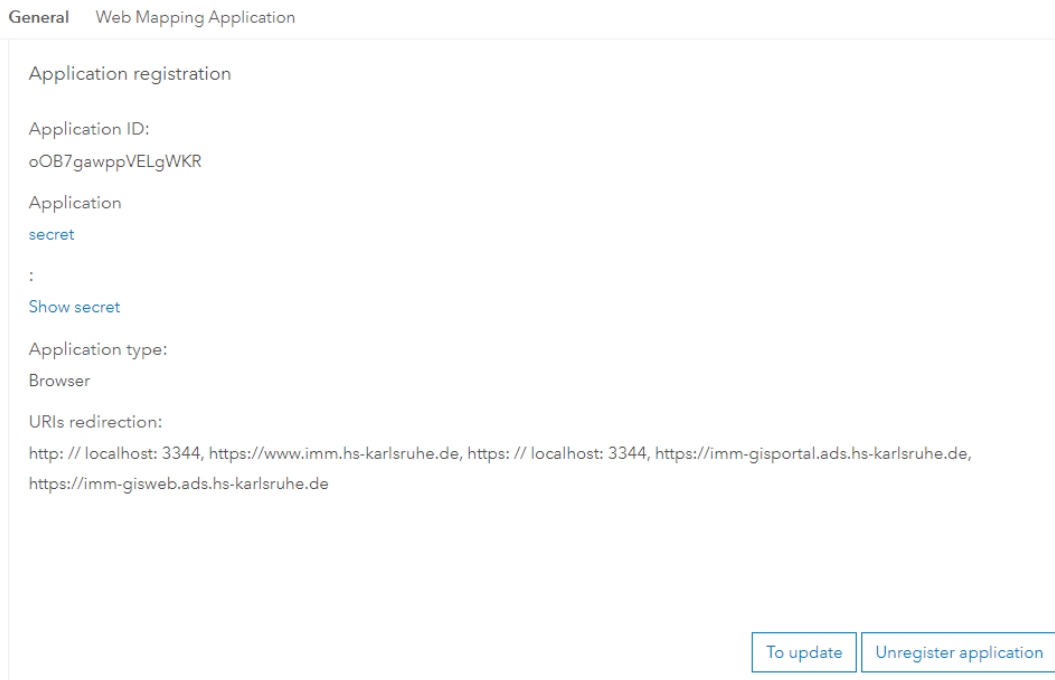

General   Web Mapping Application

Application registration

Application ID:
oOB7gawppVELgWKR

Application
secret
:
Show secret

Application type:
Browser

URIs redirection:
http: // localhost: 3344, https://www.imm.hs-karlsruhe.de, https: // localhost: 3344, https://imm-gisportal.ads.hs-karlsruhe.de, https://imm-gisweb.ads.hs-karlsruhe.de

To update   Unregister application

Figure 37: Code of the new application.

Now, the next step is to enter the ID that has been previously generated, from the browser and start creating the first application (Figure 38).
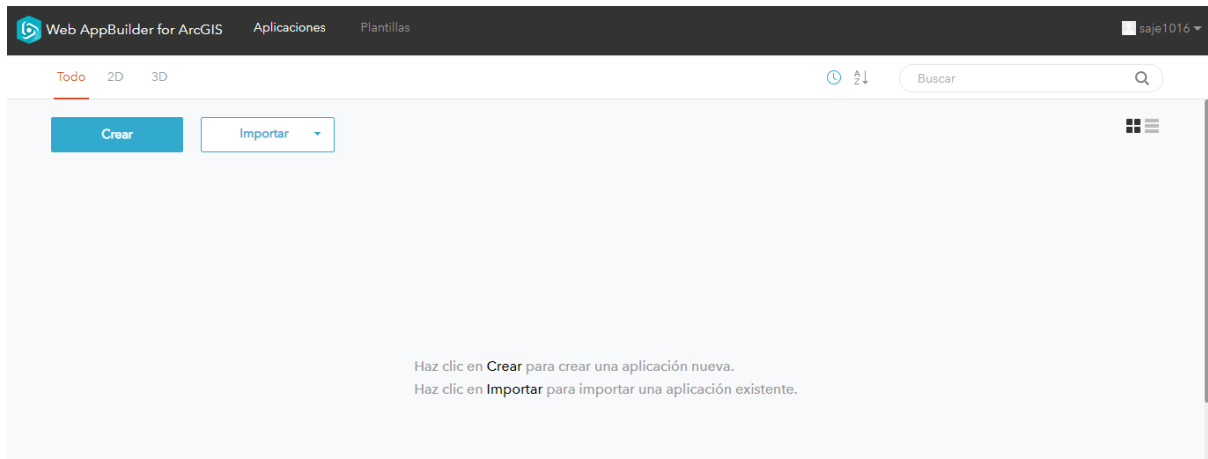

Figure 38: Menu to start the new application.

7.5 Application

As it has been mentioned in the previous chapter, the Web AppBuilder for Developers will be used for the application.

To achieve the final application, it is necessary to perform different processes. Firstly, it is necessary to create the application, the second step is to configure the map, then to add and configure the Widget, and as the last step, the final aspect will be changed. The following chapters will explain in detail how these tasks have been performed.

7.5.1 Create the new Aplication

When Web AppBuilder is already installed, the next step is to create the application.

As it is shown in the Figure 38 of the previous chapter, after installing, there are two options "Create" or "Import". In this case the "Create" option will be used. A pop-up window will appear to choose the a 2D application or a 3D application. Clicking on the 2D application option, a new window will appear where the name must be included and the thumbnail can be changed (Figure 39).
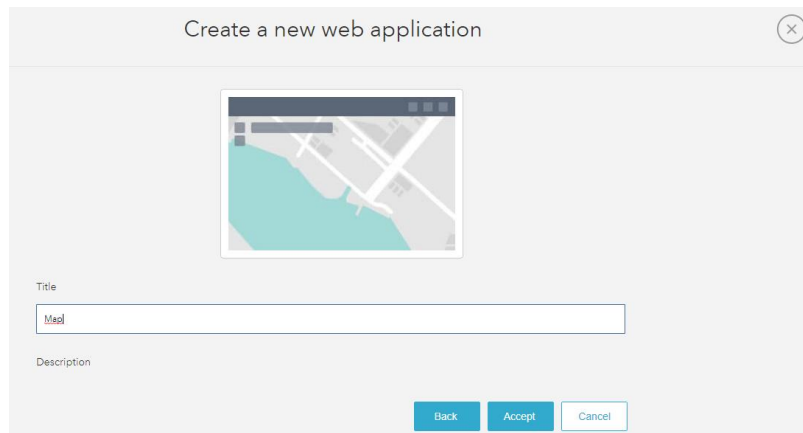

Figure 39: Creating the new application.

After new application has been created, there are different parts that must be configured to achieve the result. The appearance of the application following (Figure 40).
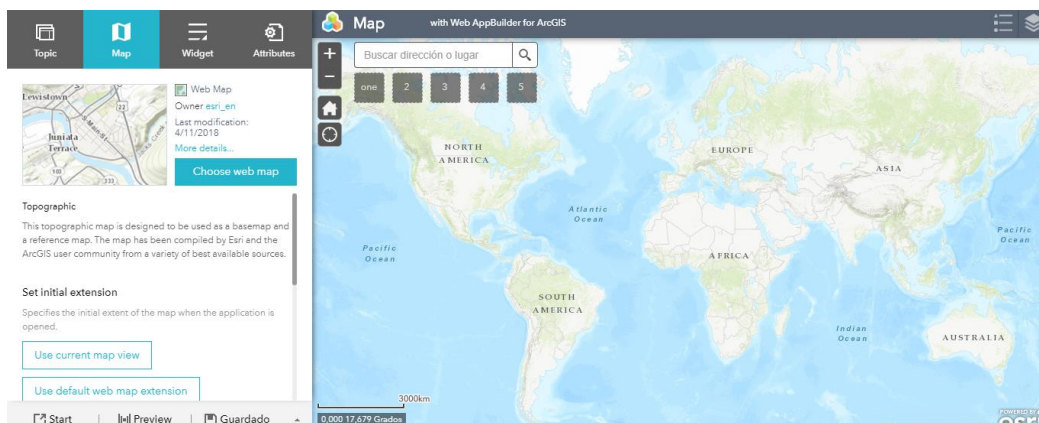

Figure 40: New application.

Several parts must be configured and modified such as the map, widget, aspect, etc., that will be explained in the following chapters.

7.5.2   Create the Map

To start creating a new map, it is necessary to have the layer already published in the Geoportal and with the appropriate style with which it wants to be displayed on the map.

To do this, go to the Portal, "My content" and open on the map (ArcGis Online) the layer with the extension of the data that was previously published (Maulbronn). As it can be seen in the following Figure 41, the extent of the data can be visualized, but it cannot be distinguished what type of data each extension corresponds to. In addition, the attribute table that will appear in the final application clicking on each of the data is not configured. Therefore, next step is to configure these aspects.
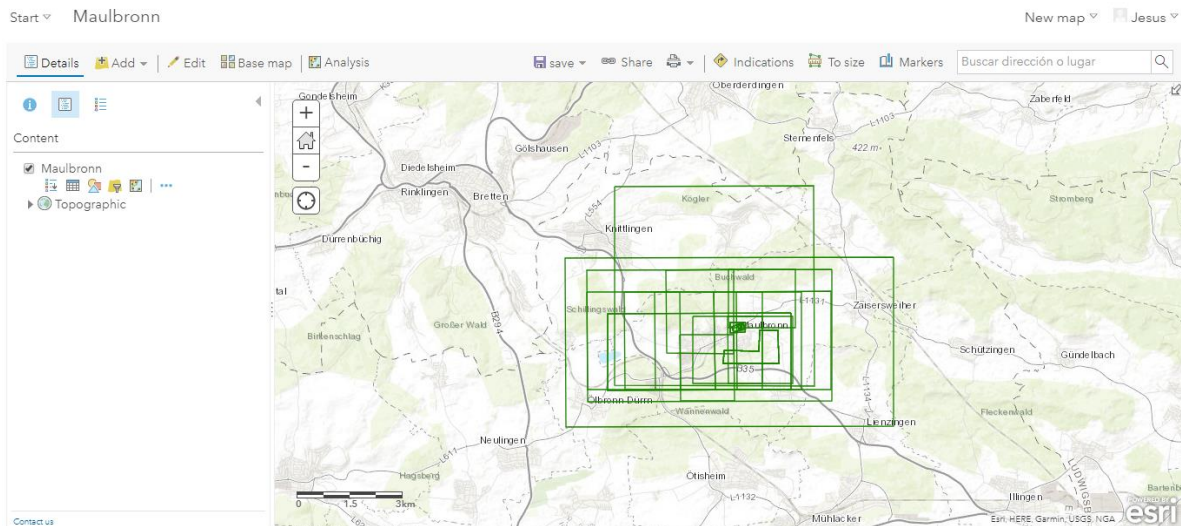

Figure 41: Layer without style.

7.5.2.1 Change the Style of the layer

As can be seen in the previous image (Figure 41), all types of data are displayed with the same colour. To apply correct style for each of layer, the following steps must be followed:

After open the map, click on the legend, and the following menu will appear (see Figure 42). In the section "1", on the left side, a drop-down become visible with the name of all the fields that the layer has in the attribute table (Type, Author, Years, etc.).
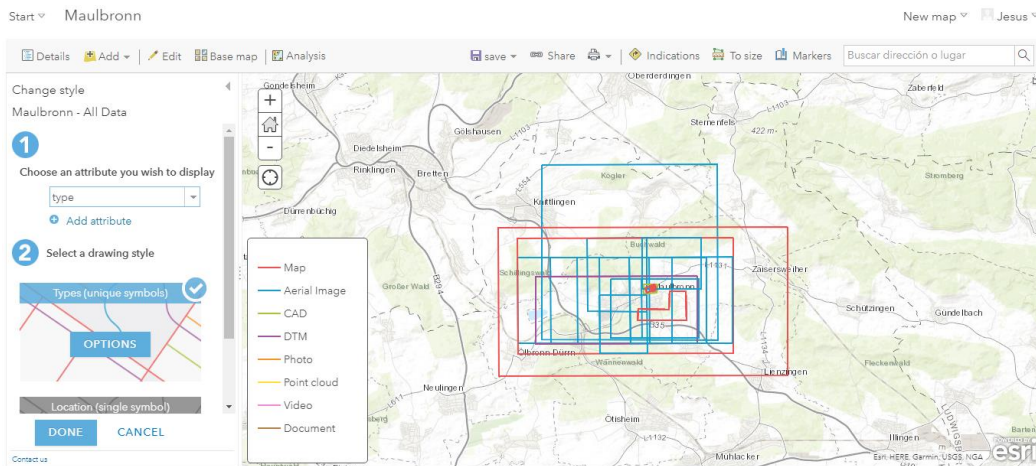
Figure 42: Changing the layer style.

When the menu that can be seen in the Figure 42 appears, in step "1", a drop-down appears where the name of all the fields that the layer has in the attribute table appears (Type, Author, Years, etc.).

In this case, the "Type" option is selected because the different data extensions are to be classified according to the type of data (Aerial Image, Map, DTM, etc.).

The next step will be to assign a different colour for each of the types, to achieve this it must already be done in the "2" section, by clicking on the "Option" button as it has been seen in Figure 42.

The following window will appear with all the data types and their colours:

By clicking on each of the data, a menu will appear where it is possible to configure the colur, line type, width, etc. (Figure 43).
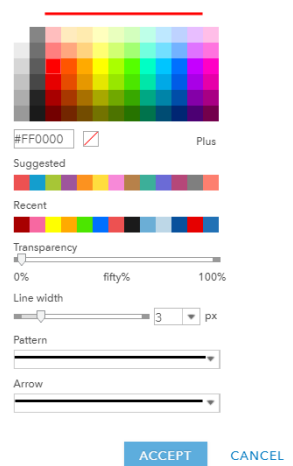

Figure 43: Changing the layer style.

Finally, a different colour is assigned to each of the data, in addition, different parameters will be assigned: continuous line, 3 px width. Finally, the final result of the legend is:
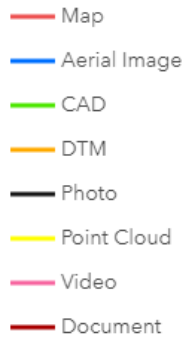
Figure 44: Final legend.

7.5.2.2 Configure popup window

When the legend is finished, the next step will be to configure the popup window.

Before to start, it is important to know in detail what the popup window is:

A map can show descriptive information about features configured to display in a pop-up. Pop-ups bring to life the attributes associated with each feature layer in the map, such as hiking trails, land values, or unemployment rates. They can show attachments, images, and charts, and can link to external web pages. You can configure pop-ups on imagery when you're working with a mosaic dataset-based image service. A pop-up on an image layer displays the attributes of images at its current location, such as the acquisition date, sensor type, and cloud cover.

To configure this, within the map, the layer options menu is opened, and "Configure Windows popup" is clicked, and the following menu will appear:
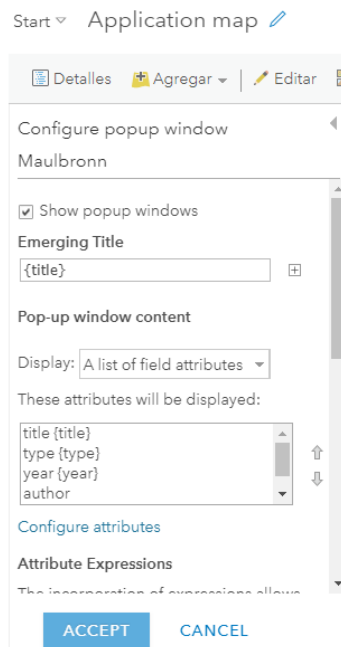

Figure 45: Configure the popup.

Firstly, with the "Show Popup Windows" option it is possible to select the Popup to be displayed or not. In this case, it will be active.

Next Figure 46 shows "Popup window content". Here, as the name implies, the fields to be displayed in the Popup are selected. In this case, only the following fields are selected:
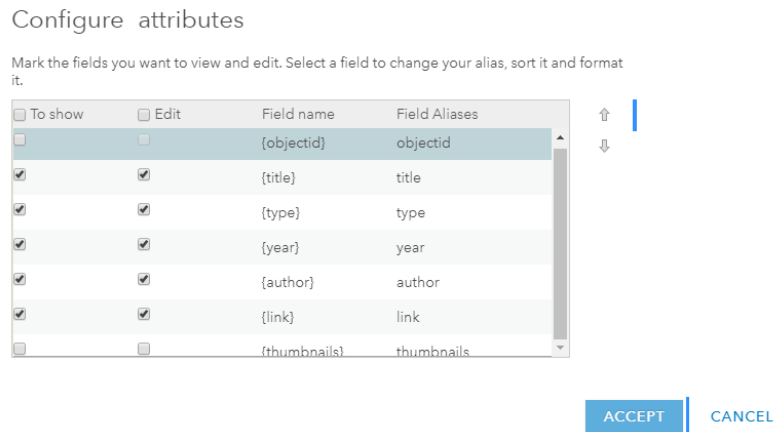

Figure 46: Data of the Popup.

The "Object" field is not selected because it is a field that is created automatically and is irrelevant for the final application. In addition, the Thumbnails field is also not selected because its purpose will be another that will be explained later.

The next step is to configure the "Multimedia content" section. This part is for the end of the popup to appear some kind of multimedia content. In this case, it has been thought to include an image that represents the data, in this way to see what this data corresponds to without having to open the data.

As can be seen in the previous image, the "Image 46" option is selected, and the following menu (Figure 47) will appear where the Thumbnails section should be configured Thumbnails.
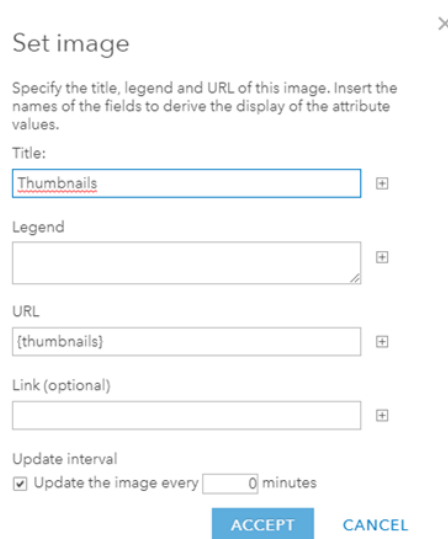

Figure 47: Configure the thumbnails.

As it can be seen in the previous image (Figure 47), the Title that will appear in the popup is "Thumbnail". Subsequently, the most important field is the "URL", where the URL of the image to appear must filled in. According to the selected extension, one or another image appears, and in the space for the URL the field of the table of attributes called "Thumbnail" will be placed. In this field, as explained above, is the URL of the image to be displayed for each of the data. After setting everything, the popup will show all the selected information and the Thumbnails.

7.5.3 Widget

Before start working with the Widgets, it is important to know what it is.

"A Widget allows you to configure the functionality of the application. It is a small application or program that runs in the application and aims to facilitate functionalities and actions to make the Application more complex."(Widget—Portal for ArcGIS | ArcGIS Enterprise, no date)

The objective of adding and including Widget in the map is to ensure that the map is more complete and that it has all the necessary functions to facilitate the user to search for data, visualize, interpret, analyse, download, etc.

First some basic Widget have been added:

- Legend: this Widget allows the legend of the layers to be displayed on the right side of the application, it is very important to be able to interpret the type of data displayed on the map easily and intuitively.
- Scale bar: at the bottom left of the map a bar appears to show the relationship between a distance on the map and its corresponding distance on the earth's surface.
- Zoom control: they are two buttons that appear in the upper left of the screen, they are used to zoom in or zoom out on the map
- Coordinates: It is a Widget that allows you to see in the lower left part of the map a box where the coordinates of the mouse pointer appear, these coordinates are expressed in Degrees.
- Start button: the objective of this Widget is to add a button to the map with which, when clicked, the map returns to the zoom level and the location that has been configured, in the case of this Application, when clicking on the button, the map will be positioned on Maulbronn.
- My location: it is a Widget that allows you to know the location where we are at the moment we click on the button.
- Full screen: allows the map to be displayed full screen.

In the following image (Figure 48), it is possible to see the layout of the widget that was just mentioned.
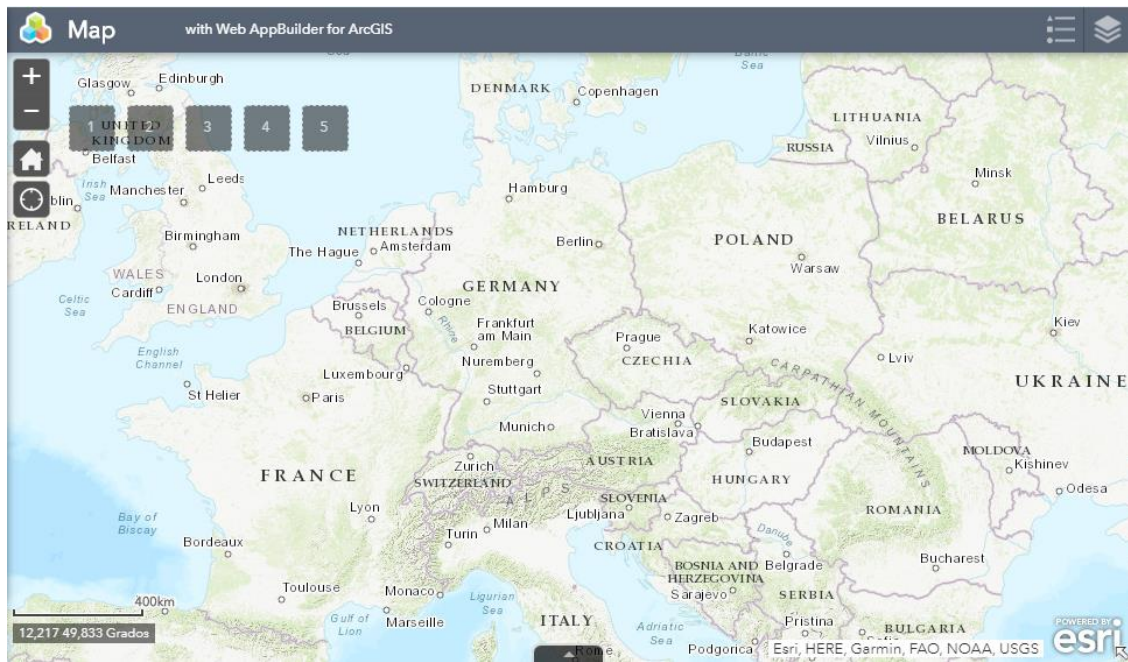
Figure 48: Map with the Widgets.

In addition, there are other specific Widget that have been in the upper left side of the screen. This Widgets will be explained and analysed in detail following:

- **Info:** The objective of this Widget is to create a Popup that is displayed when the applications start the application. In this Widget will appear information of the objective of this application and also explain the operation of the other Widget.
  Mainly it will be useful for the last Widget (Edit) since it will explain how that Widget works.
  This Widget is very useful to facilitate the understanding and use of all Widget.

- **Filter:** This Widget is very important for this application. The main objective is to be able to filter the data in order to detect only those for user's interest at any time. They can be filtered by type of data, by year or by author.
  To use this Widget, firstly, it is necessary to configure it. To do this, select the layer where all the registered data is (Maulbronn), that layer has the extension of the data, and with this Widget you can get that only the extensions that the user wants appear on the map.
  In addition, as it shown in the following Figure 49, there is an option of zooming in the results after applying the filter will be marked ("Zoom into the remaining entities once the filter is applied").
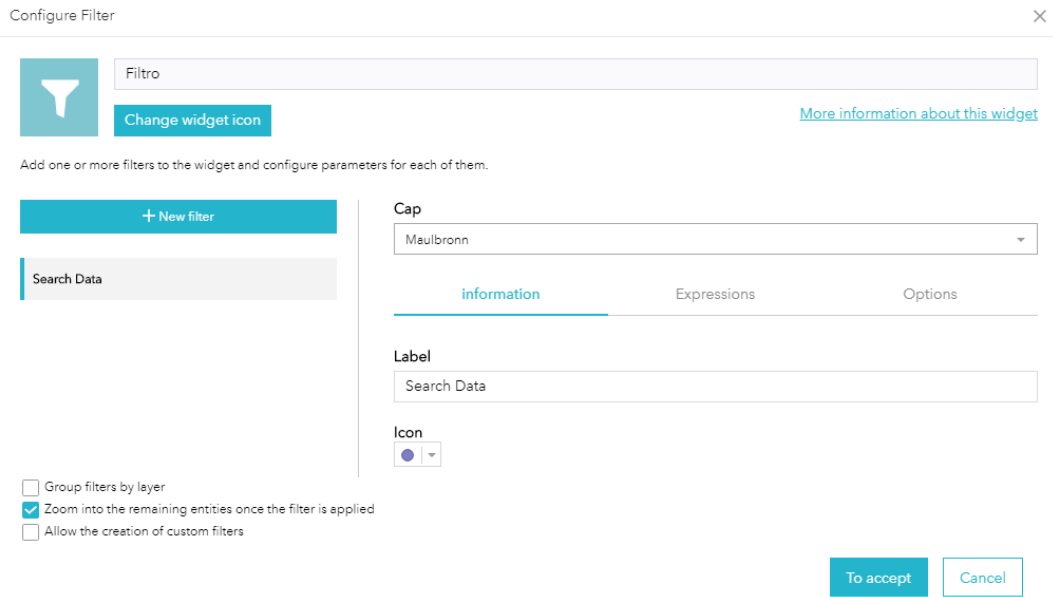
Figure 49: Configure of the Filter Widget.

As mentioned above, the three created filters that will be created will be: by type of data, by year and by author. In the following images (image 50, 51, 52) it is shown how it should be configured.
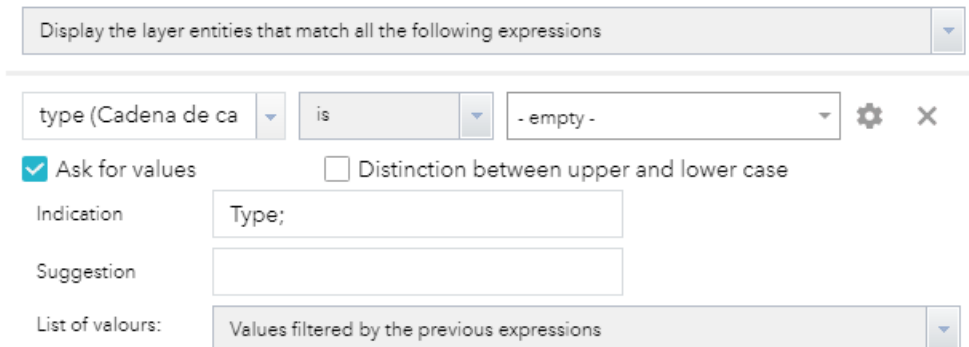

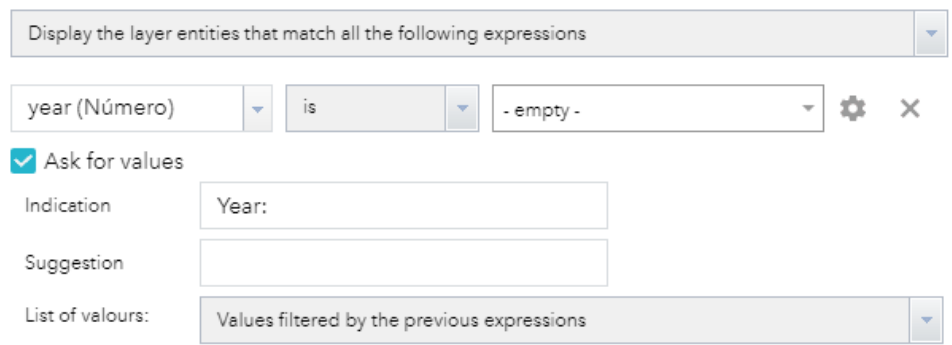
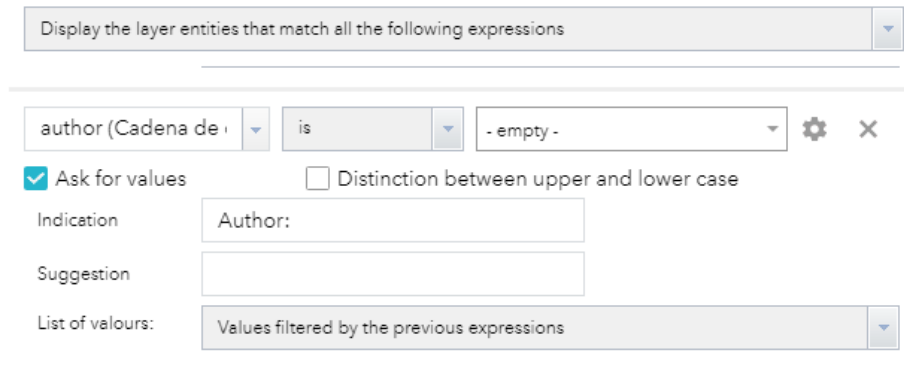*Figure 50: Query for the type.*

Figure 51: Query for the year.

Figure 52: Query for the Author.

The Widget will be configured so that for each of the three filters a drop-down appears with all the options that are stored in the attribute table of that layer. That is, in the drop-down for the "Type" filter, all types of data types that are registered will appear.

To achieve that, click on the options button on the right side, at the end of the query. Clicking on that button will show different options and the "Unique" option must be selected.

In addition, it is necessary to check the option "Ask for values"

In addition, it is also very important that the different filters can be combined, that is, if the "Aerial Image" option is selected in the filter for the data type, and in the Year filter, the "1965" option is selected, in The map will show the data that meets both filters, that is, all the aerial images of the year 1965. To achieve this, you must select the "Values filtered by the previous expressions" (Figure 53).
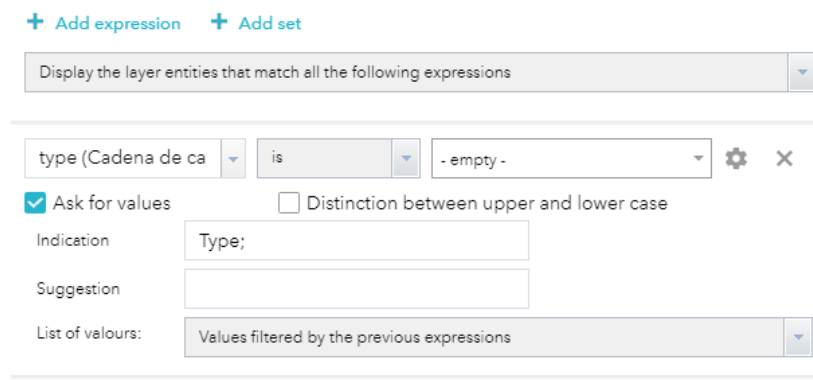

Figure 53: Parameters for the Query.

- **Query:** This Widget aims to allow data search, but in this case, the data will be searched by location, there are two options:
    - By extension of the map: it will allow that, when applying the widget, a list of all the data that is completely or partially within that extension appears.
    - Draw a polygon on the map and show the list of all the data whose extension is inside or intersecting with the drawn polygon.

To configure this Widget, it is necessary to select the option that can be seen in the following image (Figure 54) (Return only entities contained in the current map extension and return only the entities that intersect with the shape drawn on the map).
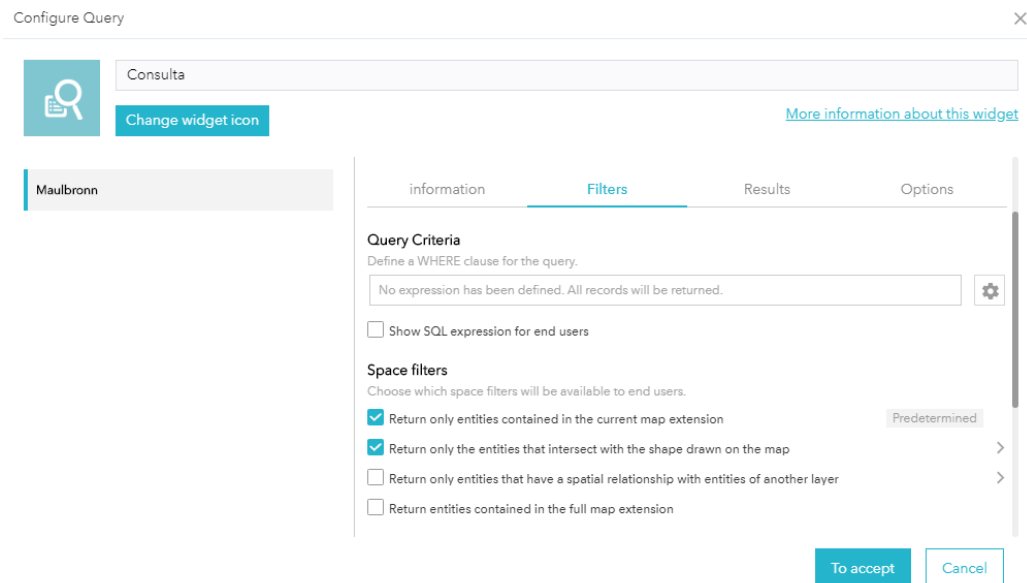

Figure 54: Configure of the Query Widget.

In addition, the second option (Return only the entities that intersect with the shape drawn on the map) can be configured so that different options for making the polygon can be chosen, in the following image it can see the options available and those chosen for this draft.
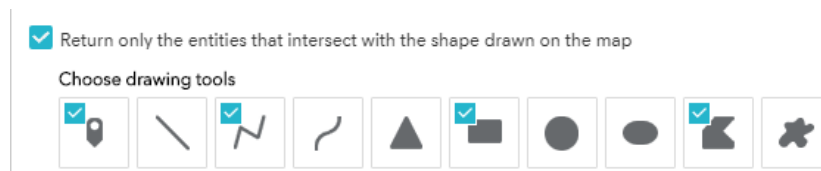

Figure 55: Ways to draw.

- **Edit:** This Widget can be considered the most important since it will allow the user to edit and add data to the application.
  As mentioned at the beginning, the objective of this application is to facilitate the search and administration of data of the monastery of Maulbronn, and to achieve that, an important part is to be able to add new data easily and quickly, so this Widget will be used.
  As for the configuration it is very easy and simple, the user only has to select the layer where the data is (Maulbronn), which will be the layer that can be edited and where new data can be added.
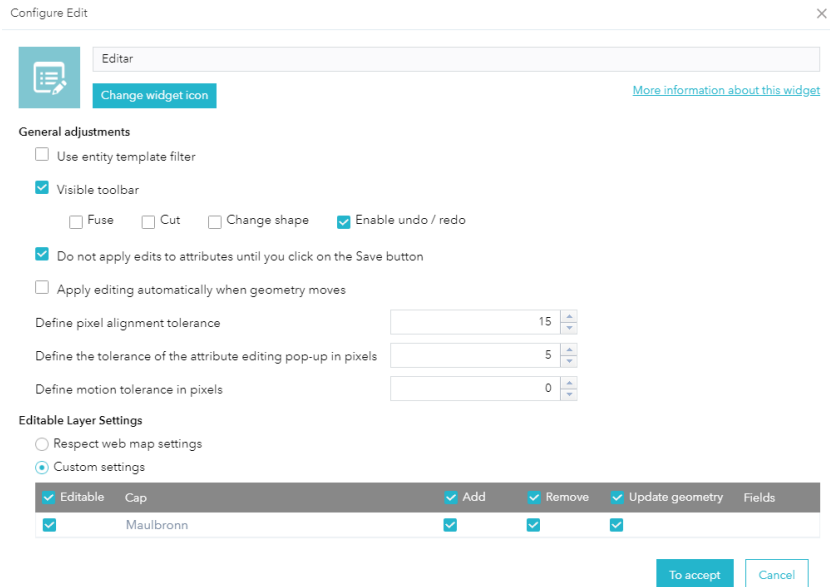
Figure 56: Edit Widget configure.

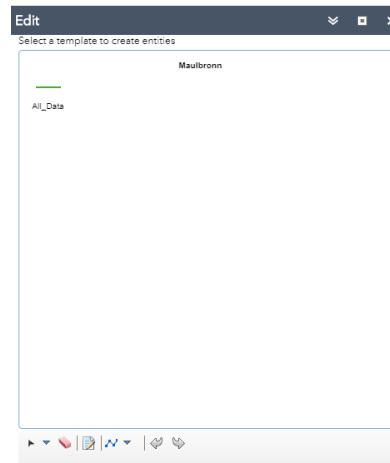When we open the Widget, the menu that can be seen in the figure 57 will appear.

Figure 57: Edit widget appearance.

7.5.4 Appearance.

The last step to finalize the application is to leave a good look, for this it will be configured to modify different things:

- It is allowed to add a logo, so the logo of the Hochschule Karlsruhe has been added.
- A title can be added, and the name of the university has been added in the title section.
- In addition, they could choose between different themes, the topic that has been considered most suitable for this application has been chosen.

7.6   Final result.

An image of the final result will be shown below, and screenshots will be shown with a small explanation of the final result.
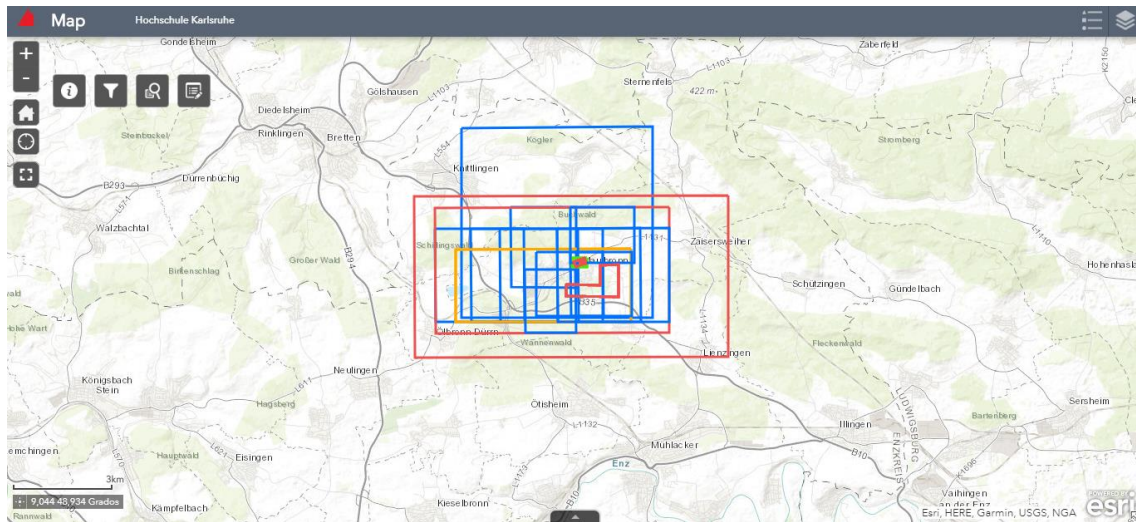

Figure 58: Final result of the application.

In the previous image (Figure 58) it is possible to see everything that was discussed and explained above, the extensions of all the data that are registered appear and all the Widget that have been added to facilitate the work of searching and adding data included.

- Data

    First, it is possible to differentiate all types of data by colour, we can open the Legend Widget and see what colour is related with what type of data (Figure 59).
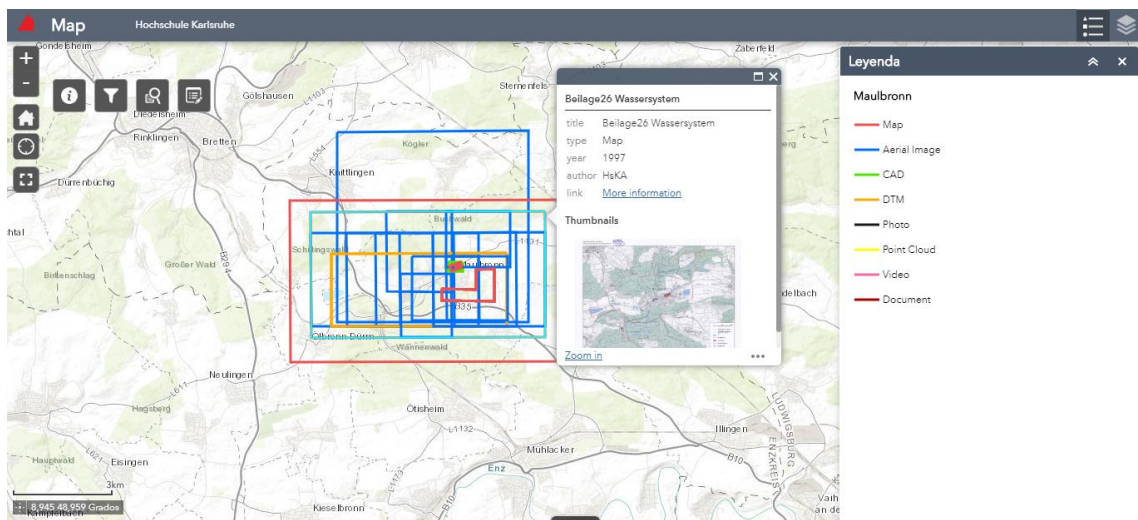

Figure 59: Final result of the legend.

In addition, the user can click on one of the extensions and the information that has been configured previously will appear (Popup with information and Thumbnail), we can see this in the following image (Figure 60).
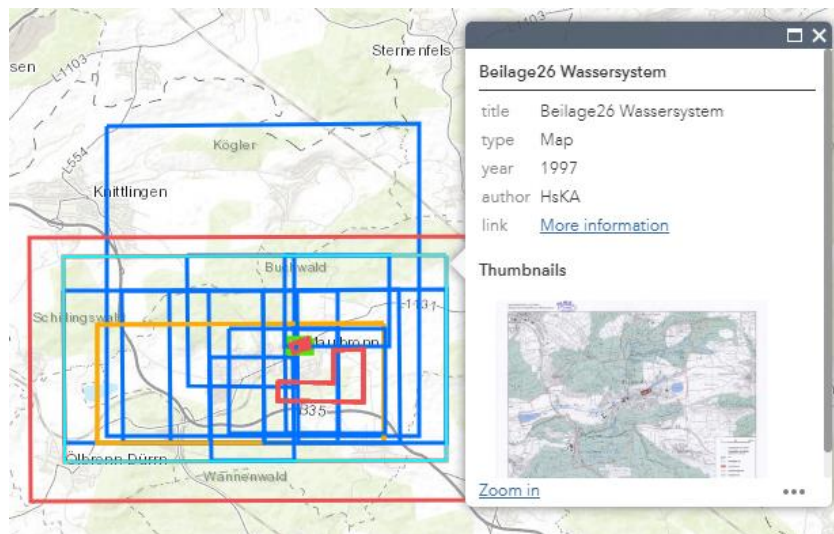

Figure 60: Final result of the popup window.

In addition, by clicking on "More information" in the "Link" section, it is possible to view and download the data associated with the extension where the user clicked.

- Widget: Each one will have a different function as explained above.
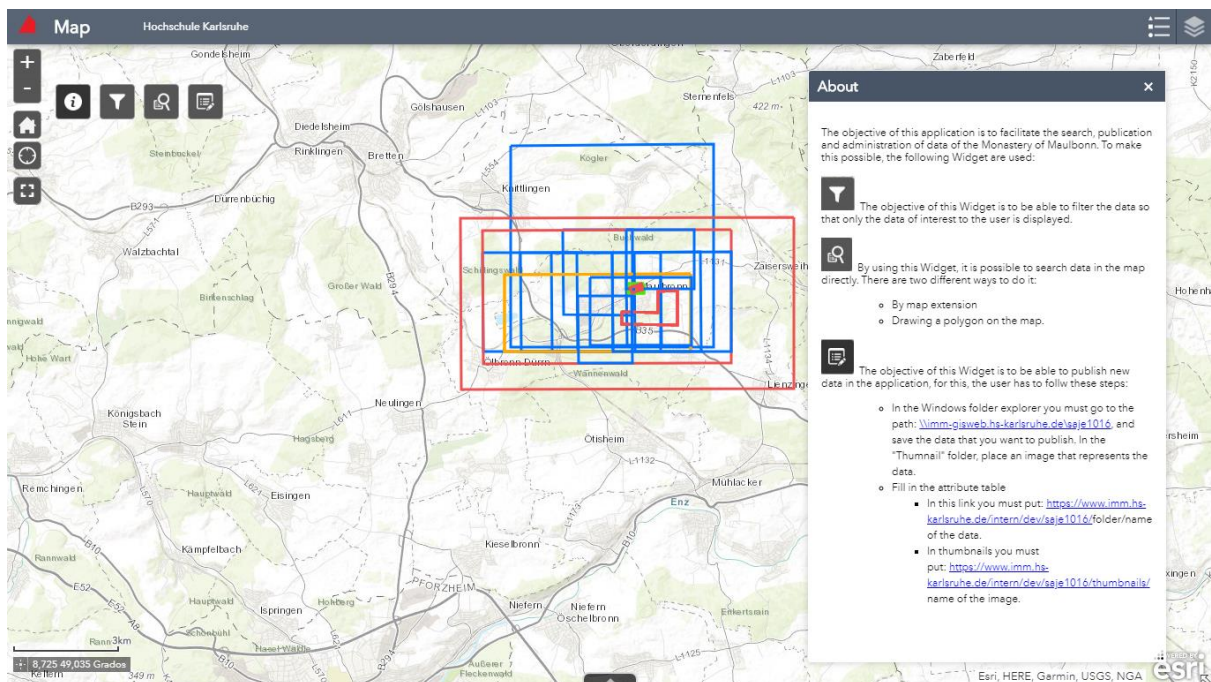   o **Info**: By opening this section, the following pop up will appear:

Figure 61: Final result of the Info Widget.

o **Filter Widget**: When we open the Widget, the following interface will appear:
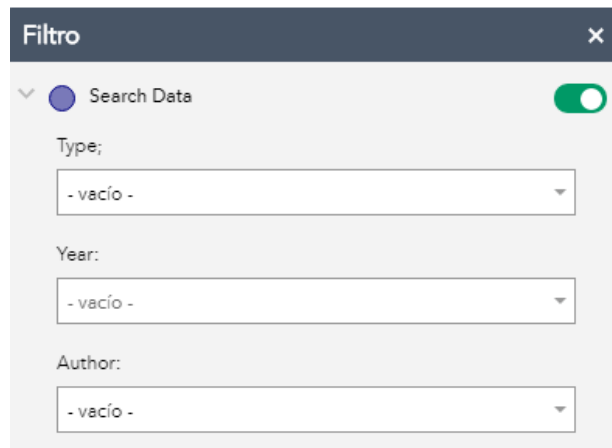

Figure 62: Final result of the Filter Widget.

The user can clearly see the three filters that have been commented previously, in addition, if you click on one of the drop-down all the data registered in the database will appear:
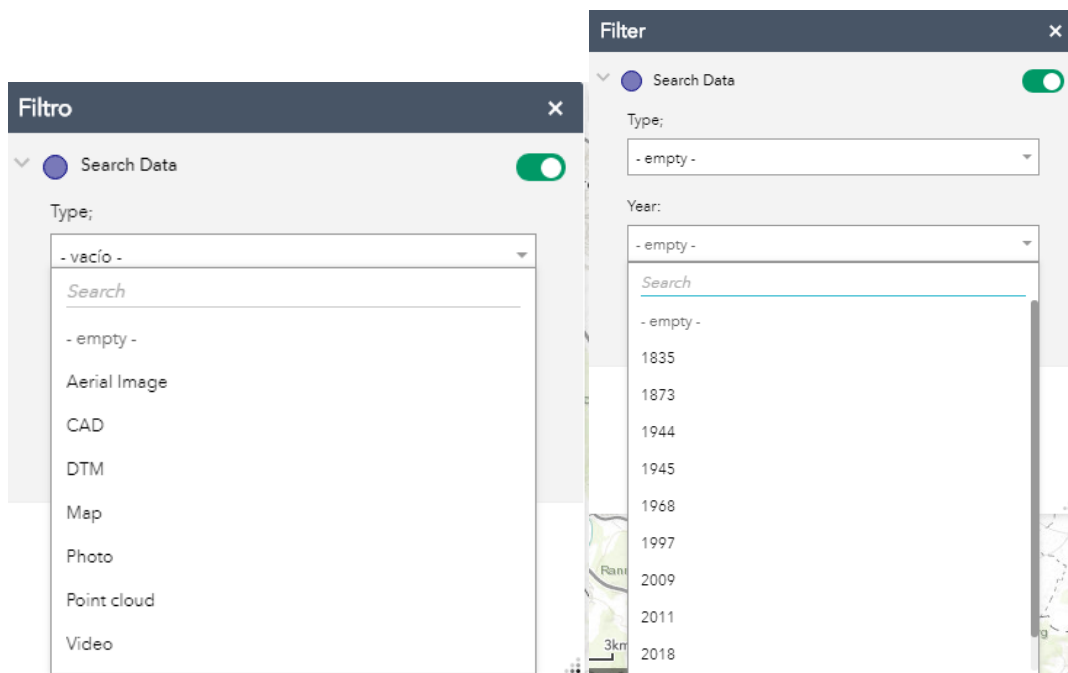

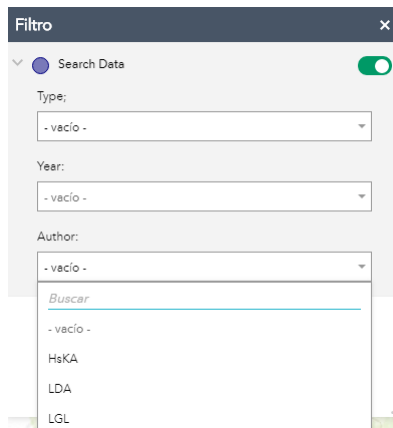
Figure 63: Type and Years filters.

Figure 64: Author filter.

But as mentioned above, if in the first filter (Type), the Map option is selected, in the next Drop-Down (Years) only the years associated with the map-type data that has been chosen will appear. The same happens with the rest of the data types. To sum up, automatically recognises the years that are related with this type of data.
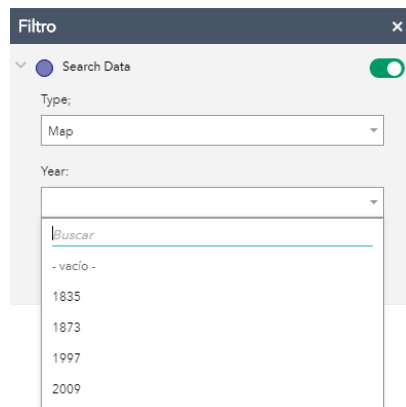

Figure 65: Filter filtered.

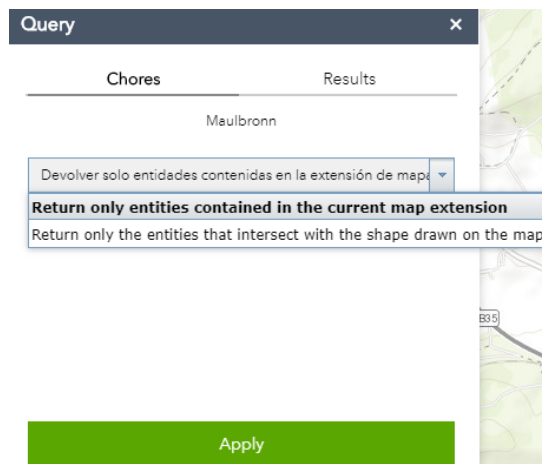o **Query filter**: Below is the interface of this Widget:

Figure 66: Query filter.

Depending on the option selected, the data search process will be different as explained in previous sections, but the result will always be the same, it will show as follows:
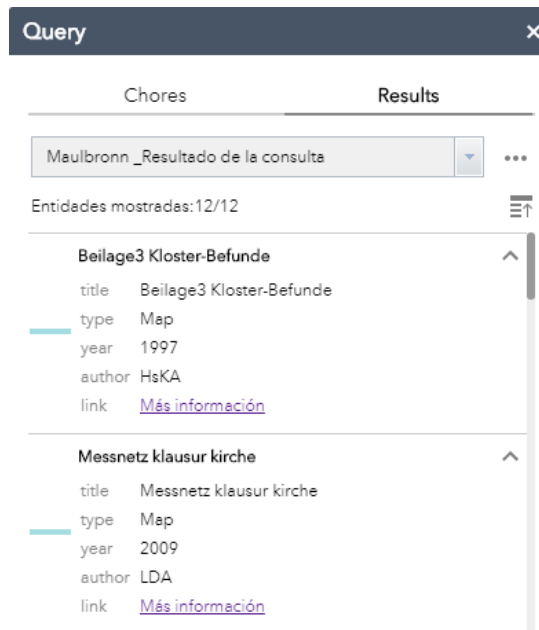

Figure 67: Window result.

o **Edit Widget**: When opening this Widget, first, the layer you want to edit must be selected (in this case there is only one layer). When the layer is chosen there are two options:
  ▪ Digitize a new record: in this case, the process is to start drawing by clicking on different points on the map drawing the extension of the data you want to add. When the extension is drawn, double click on the last point and the following form will appear:

Figure 68: Form to add data.

As it can see, all the fields that have been configured in previous sections appear.

It is also important to know that as you can see, the "Type", "Author", and "Year" fields are different from the rest, as explained

in previous chapter (domains chapter). Next, you can see a new
record added and that appears in "the database".

Aerial Image	https://www.imm.hs-karlsruhe.de/intern/dev/saje10	Aerial Image 1945	LGL	https://www.imm.hs-karlsruhe.de/intern/dev/saje10	1.945
Point Cloud	path	Point Cloud of the Monastery	HsKA	https://www.imm.hs-karlsruhe.de/intern/dev/saje10	2.019
DTM	https://www.imm.hs-karlsruhe.de/intern/dev/saje10	Maulbronn RGB of 2011	LGL	https://www.imm.hs-karlsruhe.de/intern/dev/saje10	2.011
Photo	https://www.imm.hs-karlsruhe.de/intern/dev/saje10	Maulbronn	HsKA	https://www.imm.hs-karlsruhe.de/intern/dev/saje10	2.018
Map	https://www.imm.hs-karlsruhe.de/intern/dev/saje10	Urfurkarte of 1835	LGL	https://www.imm.hs-karlsruhe.de/intern/dev/saje10	1.835
Map	https....	Map2	HsKA	https...	2.019

Figure 69: The new data in the Database.

It can see that the added records are automatically updated in the
attribute table, and of course they can be searched from the
Application using the Widgets mentioned above.

- Edit an existing record: the user can click on one of the already drawn
  records, and the table will automatically appear with all the fields and
  the information that is stored in the database. The user can also
  modify some field and if you click on the "Save" button, the information
  is updated in the database.

8. Conclusions

Regarding the general conclusions, it can be said that the main objective was to get a
platform to manage all the data of the Monastery of Maulbronn. In the first place, a
detailed investigation has been made to conclude the best option. After finishing the
project, it can be concluded that the chosen platform has been a great option since it is
a very good solution that day after day It is improving and has allowed us to obtain the
final product with all the functions and ideas we had at the beginning of the project.

With this platform and this solution, different users will have access to the Application,
where they can easily and efficiently manage all the data of the Monastery. Different
Widget can be used to find the data that the user needs, and new data can also be added
easily.

Also, it is also important to say that different techniques that are learned throughout the
Geomatics career have been used. Work has been done mainly with GIS, but
photointerpretation techniques have also been used to digitize data extensions, Web
programming, etc.

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