

Development of Intellectual Output 1 – Creating a Map-Based, Online Dashboard of DSS tools in Agriculture

Due to the different ICT developments in general, and the large diversity concerning decision support systems (DSS) in the ARD specifically, it is necessary to start with a comprehensive inventory at the beginning of the project. Many regions within Europe are comparable and allow methods that have already been tested to be adopted. For small and medium-sized agricultural companies and agricultural consultants, as well as scientists and possibly citizens, it is worthwhile, or necessary, to obtain an easily accessible overview, which shows existing developments and makes them tangible in the next step. There is no prepared and well-structured solution within the ARD, which offers all stakeholders the opportunity to get information quickly and in full. The aim of the intellectual output No 1 within the FARM project is to create an online map that represents the most relevant European ICT and DSS hotspots that were identified during this first project phase. Only the most important data are initially recorded on the map and made available to the user. With the help of the online map, agricultural businesses will have quick access to the market and will learn which tools are already in use. They can obtain a comprehensive picture of DSS development and those that are already used. The map also provides the preparatory work for two more outcomes of this project (Developing an online catalogue of DSS tools as well as developing two DSS prototypes).

This documentation provides an overview of A) the data collection for the map and B) an explanation on how the map and the dashboard were created.

A) Data collection process

The attributes of the dataset to be acquired were defined to explain maximum details about a DSS hotspot considering the European continent. The method of data collection is significantly based on a country basis. Some of the methods used to collect data are as follows. Due to the unexpected, but during the work identified big quantity and large thematical diversity of DSS, the various European countries were analysed by all FARM partners:

- *South-West European countries* by the Technical University of Cartagena (UPCT; Spain)
- *East European countries* by the Vytautas Magnus University (VMU; Lithuania)
- *South-East European countries* by Association for Internationalization of Education and Science (INTER-EDU; North Macedonia)
- *South-European countries* by University of Cyprus (UCY; Cyprus)
- *Middle and North European countries* by Harz University of Applied Sciences (HSH; Germany)

The synthesis and the technical implementation of the map has been carried out by the leader of IO 1, Harz University of Applied Sciences.

Following, the main research methods are listed including some additional remarks.

1) Keyword-based web search:

Considering the initial project preparation phase, some keywords relating to challenges, applications and many more factors. Some of them are listed below,

DSS to support:

| Increasing productivity | Allocating resources reasonably | Adapting to climate change | Avoiding food waste | Optimizing usage of nutrients, fertilizers, herbicides, and alike | Water management and irrigation strategies | Avoiding soil erosion and overfertilization | Optimizing usage of vehicles | Sustainable agricultural practices | ... - E. g.

DSS for:

| Mission planning | On-board decision-making | Route planning (on field) | Irrigation management | Optimization of water supply | Integration of agricultural practice and adaptation to climate change | Participation of agricultural stakeholders | Food waste control | Quality sustainability control | Integration of economic and ecological aspects in agricultural practice | Usage of aerial imagery and geodata to optimize fertilization | Detecting vulnerable areas | Advising farmers concerning usage of herbicides, fungicides and other means, potentially harmful in various aspects | Supporting farm management | Supporting training and further education for farmers and agricultural managers

2) Company list webpages

As previously mentioned, considering countries of interest there are webpages which give information about some registered companies in the region.

Some of the websites are:

- www.tracxn.com
- www.europages.co.uk
- www.medium.com
- www.eubusiness.com
-

3) Research publication websites

DSS hotspots are not only the companies, which are currently doing business but also the scientific and other institutions that publish innovative papers aimed at providing further information for the areas under investigation, namely DSS hotspots in European agriculture.

- ResearchGate
- Google Scholar
- Scopus
- European commission website
-

4) Agricultural universities websites

Many European countries are working currently to achieve a sustainable development to fulfil the food demand and improve agricultural practices. In order to reach this goal every country has introduced agricultural universities to research and provide facilities for scientists and students to contribute to the goals. Many of such data and project descriptions are openly available on the university websites. Many of them were filtered as per our project's needs.

5) Technology based search

Many technologies have been exploited irrespectively of the domain to solve a problem or develop a new product. Searching a technology in agriculture domain would lead to the source, which would tell how this technology has been utilised. This technology search would add many of the institutions into our database.

6) Innovative technologies on social media

There are start-ups promoting/marketing their products on social platforms, providing valuable information and utility of the product. This marketing ads or descriptions will lead to owners and their websites and can be a further valuable information source for the online map.

- LinkedIn
- Xing
- Meet.com
- Eventbrite
-

B) How to prepare an ArcGIS Online Dashboard?

In order to conceptualize and implement the online map, a broader approach has been chosen within the FARM project to add textual and graphical information, thus not relying on the map only. Such an approach is achievable by using a more comprehensive presentation format, a GIS-based digital dashboard. The requirements for the map and other dashboards elements are described briefly in the next sections.

Requirements:

- Datasets in the form of CSV, geojson, txt, gpx
- Datasets must be preprocessed with all null values removed
- Online map is required for building a dashboard

Based upon the requirements, in order to build a dashboard, geodata consisting of geographical location (Latitude and Longitude) of hotspots of decision support systems (DSS) is needed.

Dataset:

The dataset was collected in the form of an Excel Spreadsheet with the following attributes

1) Title

- This attribute describes the name of the DSS hotspot.

2) Country

- This attribute indicates about the location of DSS hotspot.

3) Region/Address

- Represents the city of a country and address of the hotspot

4) Who is the Developer?

- This attribute indicates about the owner of the hotspot. For example, CEO of the company, Research director of the institution or main researcher.

5) What are the goals?

- This attribute explains in brief the significant visions and missions/brief research description/business proposal/promises or current offers about the digital trends and decision support systems.

6) climate change, soil management, water management, economic aspects, other aspects

- Climate change: As the climate is an important influencing and limiting factor for agriculture, there will be hotspots for evaluating the weather conditions suitable for specific crops and other application areas. Such attributes tell how a hotspot is helping in this area of application.

- Soil management: Similar to climate, evaluation of soils before sowing seeds is of high significance. Tools that help in this area are marked.

- Water management: Water is a further important resource; this attribute describes how the DSS tools are taking into account water and water management strategies aiming at improving agricultural practice.

- Economic aspects: For farmers it is important to manage their capital considering the demand and supply. DSS tools that are considering these aspects are included here.

7) Literature

- Gives more detailed explanation about the DSS tool and research area.

8) Technologies/Study field

- This attribute talks about the basis or the knowledge source upon which the DSS tool is built.

9) Useful links

- For more information, links have been provided in this attribute to directly visit the hotspot online

10) Lat and Long

- These attributes represent the exact geographical location of the DSS hotspot, by latitude and longitude.

Geo Map as Feature layer

After data acquisition from all European countries, the Excel output is saved as CSV file and is uploaded onto ArcGIS as a new item.

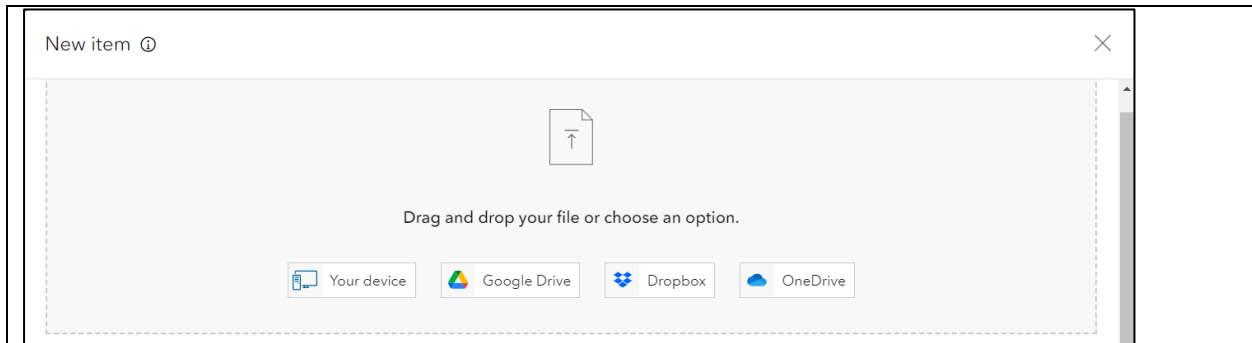


Fig 1: Dataset upload area in ArcGIS online

Once the data is uploaded, Latitude and Longitude for referencing geographical location columns need to be provided. The geographical location is detected automatically by ArcGIS online and marked as points on a Basemap (e. g. an open map, such as OpenStreetMap). Before building a dashboard, all the hotspots must be assigned with logos of the company, university or research institution.

ArcGIS allows logo assignment with the help of the image URL. An image URL is the http(s)-address linked to the image available on the internet. The image URL, however, is the only way for uploading the image onto the geographical coordinates. In fig 2 the region inside the red boundary represents the space for uploading the image.

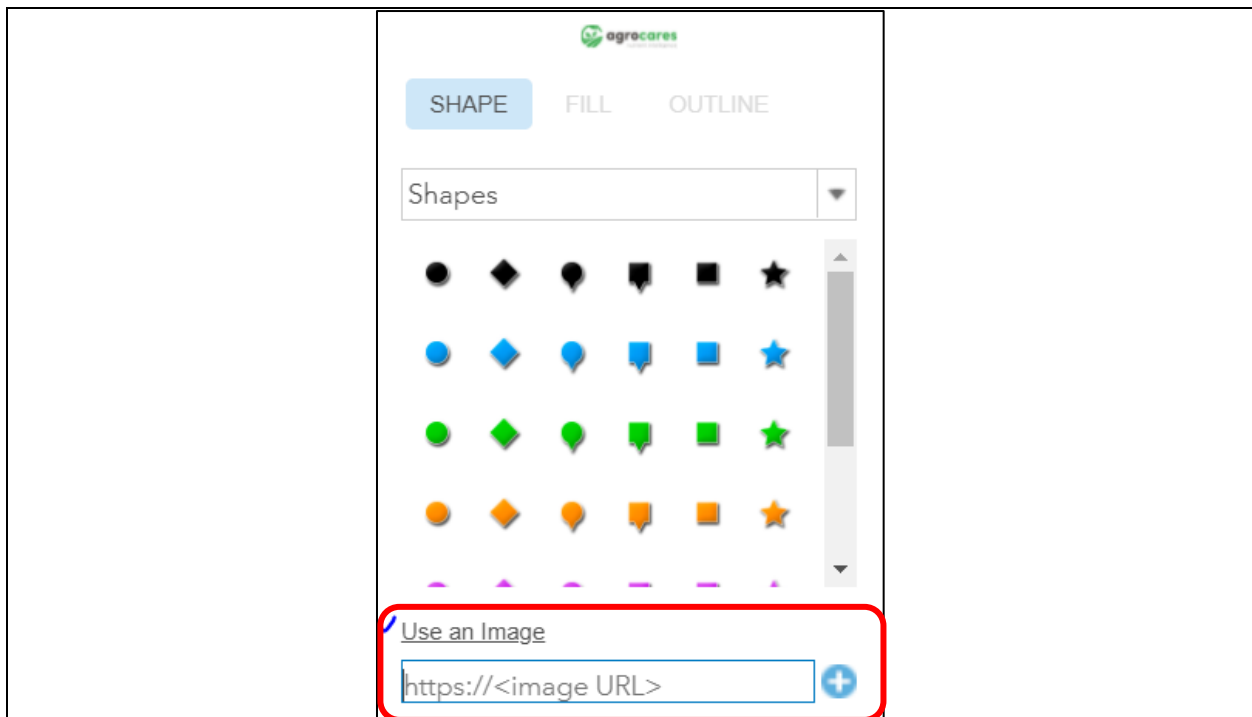


Fig 2: Image upload from URL

Once all the DSS hotspots are assigned with respective logos, the GeoMap is ready to be used in the dashboard.

Dashboard

ArcGIS Dashboard is a feature for users to convey information by presenting location-based analytics using intuitive and interactive data visualizations on a single screen. Preparing a dashboard would help us visualize some of the key factors such as the number of DSS hotspots in a particular country, technology based DSS hotspots as well as application-based hotspots. Data attributes are selected and the dashboard is created using some more elements, not only the map. Some of the features of FARM dashboard are listed below.

- 1) Count of DSS hotspots
 - The number of DSS hotspots are counted and represented in the form of Indicator, Indicator is the feature on this Dashboard.
- 2) Pie chart indicating distribution according to country
 - Country wise percentage distribution of DSS hotspots can be represented in the form of pie chart. Pie chart feature is available.
- 3) Bar chart categorization according to Technologies/Study field
 - Similar to pie chart, Bar chart feature is used to count distribution of DSS hotspots according to different Technologies or Study field.
- 4) List indicating categories according to application
 - List feature is used to describe in detail about the DSS hotspot relating to various application.

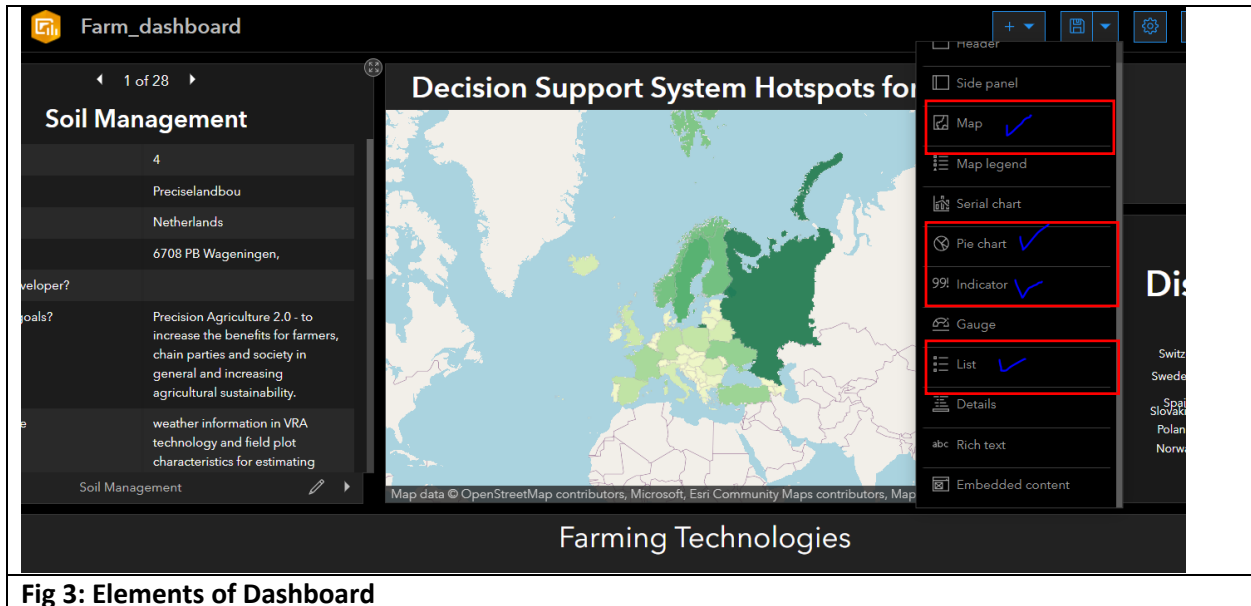


Fig 3: Elements of Dashboard

Create map-based app using ArcGIS online

A web app can be created using a variety of app builders. For example, one can choose an app template with minimal to no configuration required, and use one of the available builders to customize an app before publishing.

- After login and creation of the content, the content page must be accessed.
- At the top of the site, **Content** and the **My Content** tab have to be clicked.
- Click **Create app** and choose an app builder.
- Depending on the developer's choice of app builder, the following has to be done: For the app builders listed below, one is taken directly to the app builder and one can begin creating the app.
 - ArcGIS Dashboards
 - ArcGIS Experience Builder
 - ArcGIS Instant Apps
 - ArcGIS Hub
 - ArcGIS Story Maps

- For Configurable Apps, an app template must be chosen (using the filters to narrow your search), and via **Create Web App** the app is created.

Choose a theme

To configure the look, choose a theme for the app. A theme includes a collection of panels, styles, layouts, and preconfigured widgets.

Select a map or scene

Here, we select a map or scene that has been created newly. If Web AppBuilder with a map or scene already selected is started, it can be changed, if needed.

Add widget

Widgets provide functionality to the app, such as the ability to print an overview map. Each theme has its own preconfigured set of widgets, more can be added if required.

Configure attributes

With the configuration of attributes, one can customize the app with a logo, title, hyperlinks, and other elements. To set up content categories, **Assign Category** has to be clicked. Up to 20 categories help people to find the app. The **Filter categories** box can be used to narrow the list of categories.

Preview, save, and open

A preview of the app is possible. After the completion of the previous steps, the new app has to be saved and launched. Later it is possible to view and edit the app by accessing it in the personal ArcGIS content.

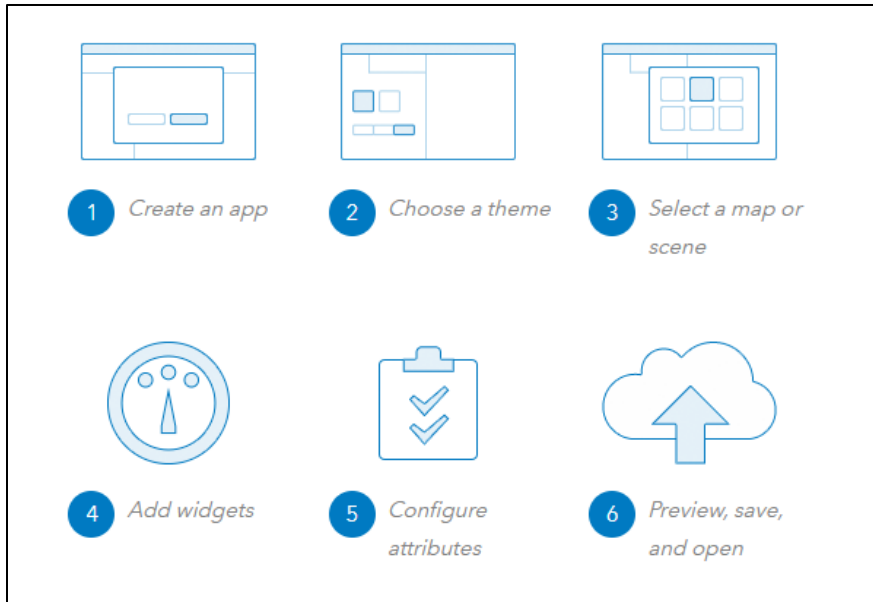


Fig 4: Steps for App creation in ArcGIS