# Geospatial Workflows and Dashboard Applications for Crisis Information

INTERNSHIP REPORT

INT- Skills- based internships/practical

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**Contents**

## 1. Introduction

I completed my internship from July 7th to August 29th, 2025, at the German Aerospace Center (DLR), more specifically the German Remote Sensing Data Center (DFD) in Oberpfaffenhofen. The DFD is part of the Earth Observation Center (EOC), which is the center of competence for earth observation in Germany. It is divided into various departments, whereby my internship took place in the Geo-Risks and Civil Security Department, which deals with the development of methods for evaluating remote sensing data and the efficient use of geospatial technologies in connection with natural disasters and humanitarian crisis. Here, I was integrated into the working group of the Center for Satellite Based Crisis Information (ZKI).

The ZKI was founded in 2004 and has since been developing innovative solutions using earth observation data to support crisis management, especially in relation to emergency mapping and humanitarian aid. Here, both earth observation data from satellites and drones as well as geospatial data in general are analyzed to provide information about a crisis and its pre- and post-situation. Since the products are primarily created to support local authorities in their decision making, they are always developed in close collaboration with the end users. In this context, the ZKI is involved in different research projects, often carried out with several DLR entities. Furthermore, the ZKI is closely linked to the International Charter Space and Major Disasters and the European Copernicus Emergency Management Service (CEMS).

## 2. Main Tasks

As part of my internship, I was introduced to the typical workflow of the ZKI and its main areas of work. In general, the products supplied by the ZKI vary greatly depending on the application area and end users. Depending on the user and their equipment, the ZKI can, for example, provide analog maps, WMS services, or web map applications in the event of a crisis. The main tasks of my internship complemented all these areas. Furthermore, I was closely involved in two ongoing research projects, namely *Resilient Technologies for Civil Protection* (RESITEK) and *Improving the sustainability of food cycles through intelligent (robotic) systems* (iFOODis), where I gained valuable insights into the diverse areas of work at the ZKI.

### 2.1 RESITEK – Dashboard Development and Data Integration

In general, the *Resilient Technologies for Civil Protection* (RESITEK) project aims to develop a continuous situation monitoring system that enables users to deploy emergency services efficiently in the event of a disaster. The aim is to combine the technologies and services of most DLR entities with a focus on space weather, resilience of power grids as well as remote guidance and mission planning into a coherent system. The project includes a joint final demonstration in the Ahr valley, where several manned and unmanned emergency vehicles will be deployed on the ground and in the air in a realistic crisis simulation. This demonstration will be carried out in close cooperation with local authorities and emergency services from civil protection and disaster control. In this context, the ZKI is responsible for implementing complex situation images that integrate relevant static and dynamic data sources, such as drone orthophotos, DEMs or object detection and census data, to enable efficient planning of new missions. The main task of my internship was to develop dashboards that support emergency responders in analyzing the impact of a disaster on the local population and infrastructure.

The continuous situation monitoring system with the implementation of complex situation images is developed with ArcGIS Experience Builder, which is why I first familiarized myself with the user interface and especially with the different widgets that can be used to create dynamic pages. Once I understood the general functionalities and possible interactions between multiple widgets, I began filtering and processing relevant data in ArcGIS Online that could later be included in the dashboards. In this context, a wide variety of data was considered, ranging from land use and object detection data to census data and real time data on damaged infrastructure. Both the selection of relevant data sources and the implementation of useful features were done with careful consideration of the user group of emergency responders who would later use the dashboards to understand the impact of the disaster and define priority areas for a faster response. For this reason, a strong focus was placed on improving usability by efficiently structuring the data into different dashboards and explaining the functionalities so that they could be understood even by users without extensive GIS knowledge.

The result is several complex situation images, the first of which dynamically visualizes land use according to the map extent in the area of the final demonstration. On the second page, I focused on real-time data on damaged infrastructure and affected person, which can be acquired by emergency responders via ArcGIS Field Maps, and is immediately displayed on the page created for this purpose. Lastly, I spent most of my time creating a series of dashboards that show the interactions between census data, object detection data and a flood mask. These three dashboards are all linked and can be used either individually or in combination depending on the user and application. The first serves as an overview of the available data sources and displays relevant statistics according to the map extent, similar to the land use page. In a second dashboard, users can use a selection widget to define an area of interest, which is then applied to automatically calculate relevant statistics for census and object detection data. These functionalities are transferred to the last dashboard, where they are expanded by a flood mask. This enables emergency responders to assess the impact of the flooding within seconds. In this context, they gain valuable insights into the extent of flooded buildings and the population distribution in the defined area (see Figure 1). At the same time, statistics on the distribution of oil heating systems have been implemented, as these can have precarious consequences for the environment in the event of flooding. Therefore, emergency services need this information on demand so they can act quickly.

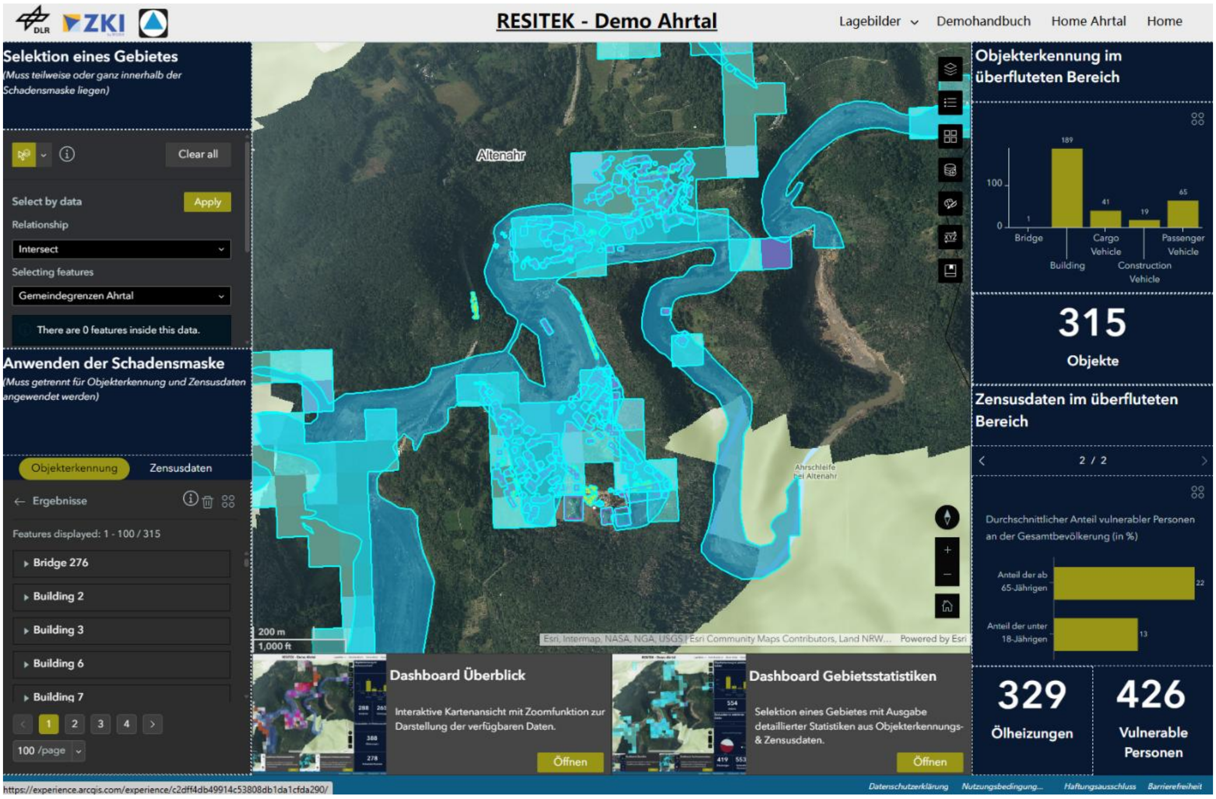


**Figure 1.** Finalized interactive dashboard with relevant statistics on flooded areas. At the bottom, a preview of the linked dashboards is provided.

### 2.2 Adaptation of ZKI Map Creation Workflows

In the event of a disaster, the ZKI can be activated to deliver rapid map products that contribute to a better understanding of the situation and its impact. These can be provided at either the national or international level. For this scenario, the ZKI has created map templates in ArcGIS Pro that enable efficient map creation and ensure reproducibility. My task was to understand the map creation instructions found in the DLR Wiki. In this context, I first reproduced map products that were created after activation under the International Charter Space and Major Disasters in February 2024. The activation was due to forest fires in Chile, particularly in the regions around Valparaìso and Navidad, where the ZKI provided maps based primarily on the EnMAP hyperspectral satellite, which gave valuable insights into the extent of the burned areas. In addition to understanding the map creation workflows, my task was also to supplement the documentation with screenshots and additional steps in the instructions. This ensures that map products can be delivered even faster in the event of future activations.

### 2.3 Raster Data Processing for Geoserver and Securing Web Map Services

ZKI users, such as local authorities or emergency services, sometimes already have their own operational services, which is why they often only request data products instead of entire web maps, such as those created with ArcGIS Experience Builder. For this scenario, the ZKI often provides its data in the form of web map services (WMS), which can be easily integrated into users' existing systems. These WMS are usually hosted with Geoserver. My task therefore was to understand how the ZKI's data products, such as drone photos, need to be preprocessed so that they can be visualized in Geoserver without any interference.

For this task, I first had to understand the main concepts of GDAL, as this translator library can be used to efficiently create raster data formats suitable for Geoserver. In this context, I used OSGeo4W Shell to execute GDAL commands, specifically to create cloud-optimized GeoTIFFs and use efficient compression methods. The preprocessed raster data was then uploaded to Geoserver to create WMS. Since the first attempts resulted in black borders in the WMS, I began researching different compression methods such as JPEG, LZW or DEFLATE, their advantages and use cases. In the end, I created an efficient workflow that uses the JPEG compression algorithm to reduce file size while defining an internal mask to avoid unwanted edges at the borders of the WMS. Since DLR products often consist of different images that need to be combined for the WMS, I also established a workflow for creating a mosaic with GDAL. This last step can also be performed in ArcGIS Pro, depending on whether the final product is only uploaded to Geoserver or also to ArcGIS Online. Similar to the adaptation of ZKI map creation workflows, I here also improved the existing instructions in the DLR Wiki with my own results.

In connection with Geoserver and the publication of WMS, it was also my task to find ways to secure a WMS, as the ZKI's data products are often confidential and should not be made accessible to all users. To do this, I first had to understand how security works in Geoserver with the functions of users, groups and roles as well as service access rules and authentication. To ensure that the ZKI can efficiently create password-protected WMS in the future, I created ready-to-use users with the associated roles. At the same time, I explained and documented how to set up a password-protected WMS in the DLR Wiki using the example of a WMS for floods. I then tested this specific secure WMS for various use cases such as opening the WMS in QGIS and ArcGIS Pro. To achieve the desired response from the WMS with an automatic query of the username and password, I had to adjust the settings in Geoserver accordingly. Additionally, to upload the password-protected WMS to ArcGIS Online, I had to do some research and discovered that it had to be added to the organization's list of trusted servers in order to be accepted by ArcGIS Online. Finally, I tested the use case of adding a password-protected WMS to a published ZKI web map with various data sources. The result was that only verified users could see the WMS, while users who could not provide the correct username and password could only see the non-confidential data sources.

**2.4 iFOODis – Environmental Data Research and Analysis**

During the final weeks of my internship, I was introduced to the ongoing research project *Improving the sustainability of food cycles through intelligent (robotic) systems* (iFOODis), which aims to improve sustainable food production through a continuous monitoring network based on satellites as well as robotic and sensor networks in the air, on the ground and in the water. In this context, the condition of terrestrial and surface water ecosystems in relation to agricultural activities is to be assessed in particular. Here, a special focus is placed on future agriculture in the Baltic Sea region with a test site in the Schlei region of Schleswig-Holstein, where a monitoring sensor network has been set up that continuously measures 39 biogeochemical and physical parameters. The ZKI is responsible for situational awareness and data management by visualizing the results in complex situation images and publishing relevant information to PANGEA Data Publisher to comply with FAIR principles.

Here, my first task was to research available geodata products for various environmental parameters which can later be used to create an overview of the situation for the project, especially in the Schlei region. In this context, I expanded the data collection of the ZKI to include suitable data sets for various environmental categories such as meteorology, hydrology and geology, which can mainly be accessed via WMS and can therefore be easily implemented in ArcGIS applications.

Additionally, my task was to use available satellite data from Sentinel-2, WorldView and EnMAP to calculate spectral indices which could later be correlated with in-situ measurements in the Schlei region. In addition to common indices such as the Normalized Difference Vegetation Index (NDVI), I also investigated which indices are especially useful for the available data sources with their different spatial and spectral resolutions. A particular focus was placed on deriving a proxy for chlorophyll-a in the waters of the Schlei region. In this context, I calculated the Normalized Difference Chlorophyll Index (NDCI) for the water mask in the test area and used a custom script from sentinelhub that provides an estimate of the chlorophyll-a content for cyanobacteria blooms in surface waterbodies.

Lastly, I was asked to calculate soil surface moisture (SSM) in the Schlei region based on Sentinel-1 images, as the soil surface moisture provided by the Copernicus Land Monitoring Service has a spatial resolution of 1 km and is therefore unsuitable for visualizing SSM in smaller test areas such as a single agricultural field (see Figure 2). To do this, I followed a tutorial that estimates soil moisture using Sentinel-1 data in Google Earth Engine. Here, I executed the script for AOIs of different sizes, such as the entire Schlei Nature Park or a single agricultural field, to compare the results with the Copernicus product. At the same time, I tested the script with both 30m and 10m resolution and adjusted the focal mean value used to smoothen the image and to reduce speckle noise.

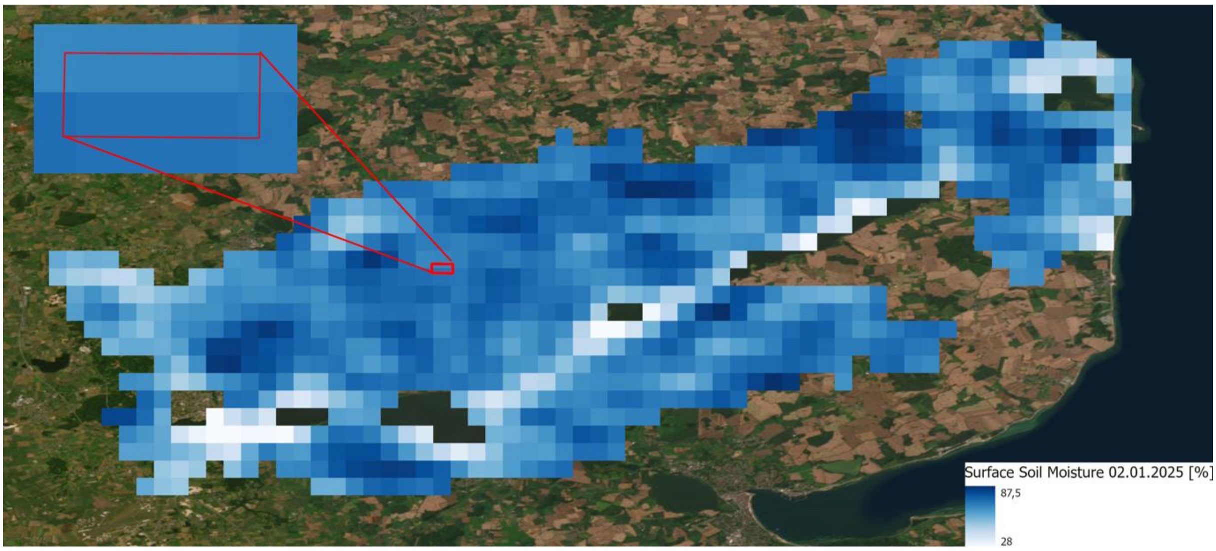


**Figure 2.** Surface Soil Moisture for the Schlei Nature Park in January 2025 based on the Copernicus Land Monitoring Service product. The area at the top left shows the SSM for a single agricultural field with a spatial resolution of 1 km.

While differences in soil surface moisture for a single agricultural field are not detectable with the Copernicus product at a spatial resolution of 1km, the own calculation of SSM at a spatial resolution of 10m shows clear differences for a smaller area (see Figure 3). These results are important in the context of the project, as they can be used to visualize smaller AOIs in complex situation images. In addition, I was asked to calculate time series from SSM based on the Google Earth Engine script, as shown in *Figure 4*, since these results can best be correlated and compared with the in-situ measurements from the monitoring sensor network.

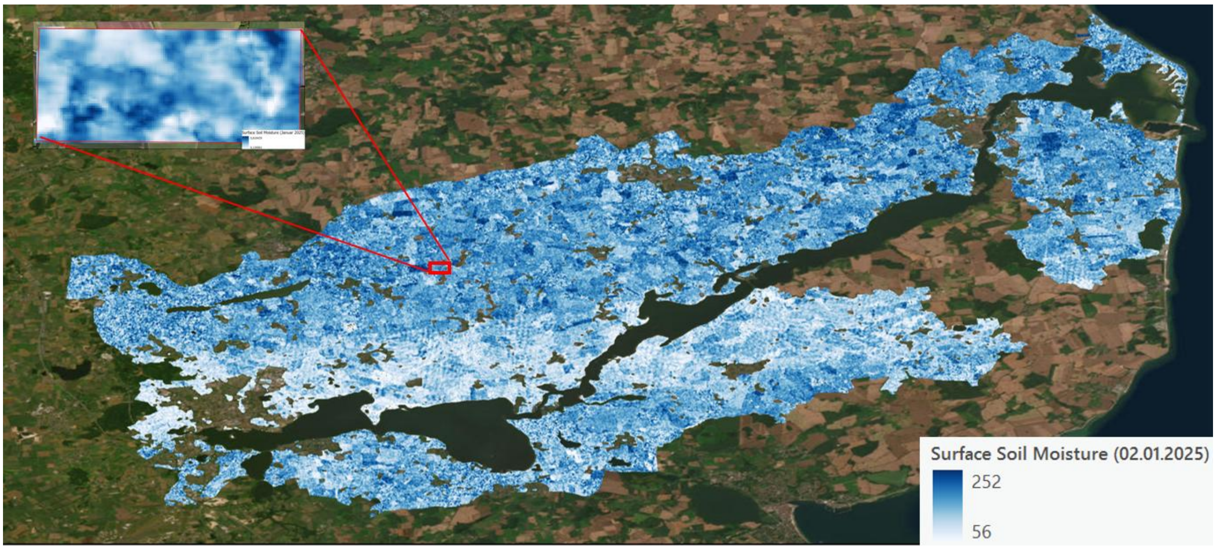


**Figure 3.** Surface soil moisture for the Schlei Nature Park in January 2025 based on Sentinel-1. The area in the upper left shows the SSM for a single agricultural field at 10m spatial resolution.

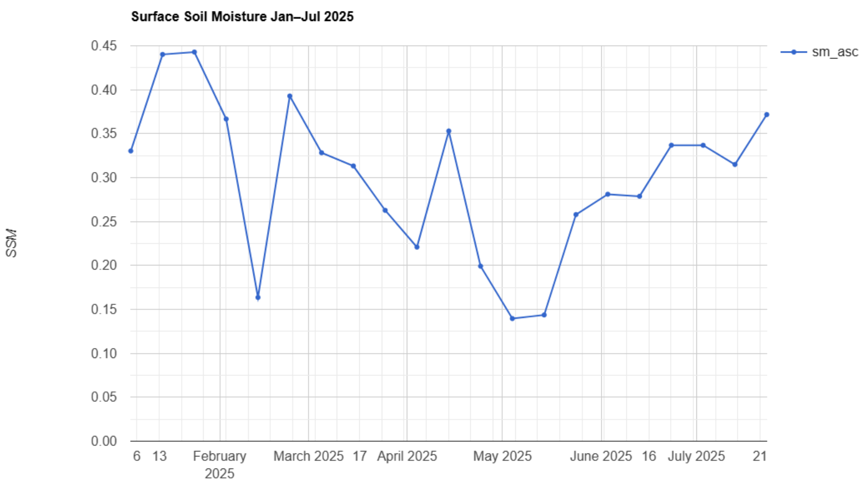


**Figure 4.** Time series of surface soil moisture in the Schlei region from January to July 2025 based on Sentinel-1.

## 3. Conclusion

This internship was an invaluable experience for me, as I was able to improve my skills while gaining insights into a leading research institution in the earth observation domain. It was extremely interesting to learn about the wide range of work carried out by the ZKI, which continues to focus on crisis information, as I was already interested in this topic before starting the internship. I especially liked gaining completely new skills such as learning about ArcGIS Experience Builder, GDAL and Geoserver, as these skills could be useful in the future, for example for my master’s thesis. Furthermore, I really enjoyed contributing to ongoing research projects dealing with relevant topics such as disaster management and food security. In this context, it was also great that I was able to use some of the knowledge I acquired during my bachelor's degree in environmental geosciences to understand the relationships between different components of the natural environment for the iFOODis project. All in all, I firmly believe that this internship has prepared me well for my future academic and professional career, especially for a traineeship that I would like to pursue after completing my master's degree.

Lastly, I would like to thank DLR for this internship opportunity and my colleagues for giving me valuable insights into their areas of work and helping me improve my technical as well as soft skills. Additionally, I would especially like to thank my two supervisors, Anne Schneibel and Magdalena Halbgewachs, for their advice and honest feedback during the internship, as this helped me to grow professionally and prepare myself for future professions.