

# Investigation of Dynamic Visualization of WMS with Additional Dimensions in a WebGIS

Geodata-holding agencies and organizations enable access to a growing amount of geodata on a wide variety of topics through provided Web Map Services (WMSs). Often, provided geodata on one topic is available for different times, elevations, or other dimensions. Thus, geodata may exhibit more dimensions besides its two-dimensional spatial reference system. For instance, maps of weather forecasts may show the predicted conditions for different points in time and elevations. The OGC standard WMS offers the possibility to define such additional dimensions for each layer. Therefore, many geodata holding agencies and organizations provide WMS layers with dimensions.

## Dimensional WMS Layer

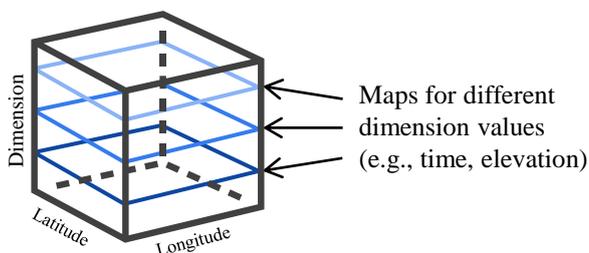
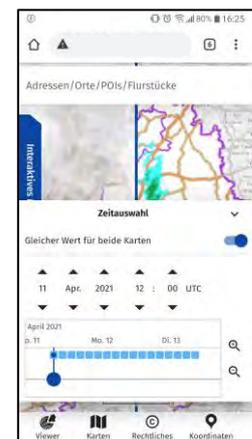
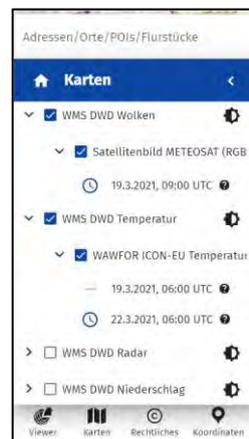


Illustration of a dimensional WMS layer

Although additional dimensions are defined in the WMS standard, few WebGIS implementations allow the user to explore the data in its dimensions, and if they do, they often provide limited support. Standard conformity is crucial in the context of distributed data to ensure interoperability. Nevertheless, little knowledge exists on how to provide dimensional support in a WebGIS viewer while considering the usability, User Experience (UX), and access from mobile devices.

Therefore, this thesis aims to examine possibilities for dimension visualization and user control and the visual comparison of WMS layers regarding dimensions in a WebGIS.

To achieve that aim, different approaches for visualization, control, and map comparison are analyzed and evaluated considering usability and mobile usage. Based on the analysis results, a user interface concept is developed for the WebGIS of the ISB AG considering UX/UI design principles. According to the mobile-first design, the concept is developed for mobile devices. Afterward, the new functionality to visualize and compare WMS layers with dimensions is prototypically implemented for the ISB WebGIS. For the implementation, open-source technologies are used like the TypeScript-based web application framework Angular, Angular Material Design for the UI components and OpenLayers. Finally, the prototype is evaluated. Implications and the suitability of WMS to display geodata with additional dimensions in a WebGIS are discussed.



Screenshots of the service catalog with dimensional layers (left) and the selection of a time for two compared maps (right)

This thesis demonstrates how dimensional exploration of WMS layers can be realized in a WebGIS. A 2D visualization of specified dimension values of a layer with controls for the dimension selection is a useful approach. Dropdown menus, text inputs, and a comprehensive dimension axis facilitate a proper dimension selection. A broad comparison functionality regarding dimensions is achieved with superimposition as map comparison approach, and the two supported use cases layer comparison and dimensional comparison. This thesis shows that a WMS is generally suitable to display geodata with additional dimensions.