

INTERACTIVE SNOW MAPS OF THE TERRITORY OF SLOVAKIA

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This contribution is devoted to the presentation of technological aspects of building the database and application solution of Climate atlas of Slovakia. It shows the architecture of its structure and describes the components of software and server based processes – database server, GIS server and application server stressing the computational, mostly interpolation functions. Consequently it describes the structure of the data and mapping and geo-processing services. Further to that client components are described – the functionality of web-gis application in public (internet) and private (intranet) option with practical demonstration of mapping and functional possibilities focused on the statistics of snowfall data (f. ex. average number of days with snowfall, average number of days with a certain height of new snow cover, average day with first and last day of snowing, etc.) and snow cover data (f. ex. average seasonal number of days with snow cover, average monthly number of days with snow cover, average monthly maximum of snow cover, average monthly maximum of snow water equivalent, etc.)

Key words: web-gis application, snowfall, snow cover, snow water equivalent

INTRODUCTION

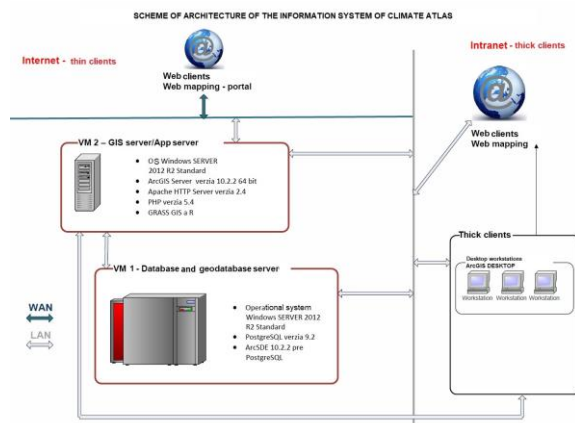
In 2014 a comprehensive work “Climate Atlas of Slovakia” was accomplished in the cooperation of ESPRIT company and Slovak Hydrometeorological Institute with following activities:

- establishing of complex information system including data store and web GIS software
- establishing of database of data which influence climate system (abiocomplex, and geodatabase of land use)
- creation of digital map assembly for the use of electronic book and web map services
- creation of electronic book

Interactive snow maps form a part of database as well as a part applied solution of the information system of Climate Atlas of Slovakia

THE ARCHITECTURE OF THE IS OF CLIMATE ATLAS OF SLOVAKIA

Due to the space character of the major part of information and functional demands of the project geographic information systems (GIS) formed the main tools to process, administrate as well as to present climatic and supportive data. Due to the big volume of processed information and data GIS in its extensive structure was employed which comprised server oriented database for all data, GIS server components for the management and for to generate map and geoprocessing and interpolation services and client components consisted of out of web-GIS solution for thin clients (map application in the environment of internet browsers) and desktop GIS for thick clients. The architecture of the system is presented in following scheme:



As the database and geodatabase server for the management and implementation of data model of space data and interpreted climatological data SQL database PostGRE is used together with the technology ESRI SDE v 10.2 (spatial database engine) for multi-users management of space data in database systems of SQL.

ESRI ArcGIS SERVER v 10.2 in the version of STANDARD ENTERPRISE is used as GIS server platform for to support standars server oriented GIS functionalities and GRASS GIS to the support of interpolation functionalities.

Application container (WEB server) for administration WEB GIS map application is constructed on APACHE (v2.4.10) technique in combination with PHP v5.4.

For administration and management of geographical data, creation of cartographic models and extended GIS functionality **desktop version (thick client) of GIS ArcGIS DESKTOP** from ESRI in STANDARD version is used.

GIS-web application used as the main client tool GIS service of server components (ArcGIS Server, GRASS GIS) and data of database server through special developed modules and it is available in different versions from both intranet and from internet. It does not require any specific installation, only the connectivity to application server and operational web browser is necessary. The application is implemented in two functional versions – public version with restricted functionalities is accessible from the web page of Slovak Hydrometeorological Institute (SHMI). Expert version is dedicated to restricted band of specialists and is accessible only in secured part of SHMI intranet. Detail functionality of GIS-web application will be described in further parts of this article.

THE EXTENT OF THE DATABASE OF THE IS OF CLIMATE ATLAS OF SLOVAKIA

The structure of climate data:

Temperature:

- Mean annual air temperature
- Mean seasonal air temperature
- Mean monthly air temperature
- Mean temperature of warm half-year

Precipitation:

- Mean precipitation totals [mm]
- Number of days with precipitation

- Extreme precipitation totals [mm]
- Precipitation inices and drought

Snow:

- Number of days with snowfall
- Snow cover height
- New snow cover

- Air humidity and evapotranspiration**
- Sunshine duration, radiation and cloud cover**
- Ait pressure and wind**
- Phenological characteristics**
- Soil temperature and soil freezing**
- Climate classification**

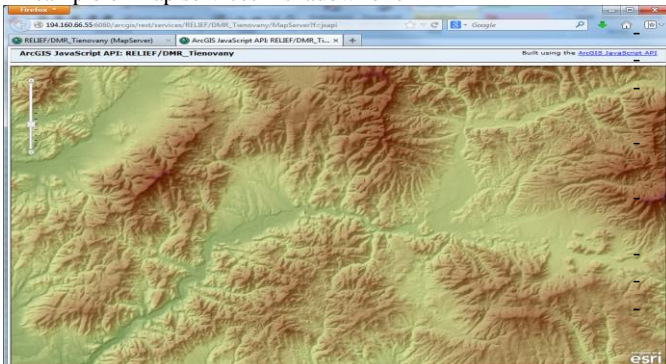
To create the Climate Atlas of Slovakia it was necessary to obtain, further to the climate data, a number of supportive data which influence the climate system or the data necessary for GIS and cartographic interpretation. The data was processed by using standard GIS technologies in such a way which fulfilled the legislative, qualitative and technological demands. The methods used had to be able to remove spatial and logical discrepancies. Consequently, they were implemented into the system in following structure:

- Digital model of relief (DMR)
- Orientation (exposition) of the relief Inclination of the slopes (georelief)
- Hypsographic grades
- Solar radiance
- Vertical division of the relief
- Exposition to the prevailing air flow
- Positional types of the relief
- Geomorphologic units
- Climate regions
- Morphographic - positional types of relief
- Morphoclimatic units
- Land cover classes
- Hydrological catchments (detail, basic, main)
- River network
- Water areas
- Roads
- Rail roads
- Territorial units
- Administrative units

MAP SERVICES OF THE IS OF CLIMATE ATLAS OF SLOVAKIA

By using cartographic visualization of the maps and by their publishing by the GIS server we obtain so called map services. They form the basic visualized documents shown by web-GIS server and they provide simple user interactivity -e.g. the selection and combination of different layers of maps and the definition of the area of the interest.

A sample of map services – shadow relief



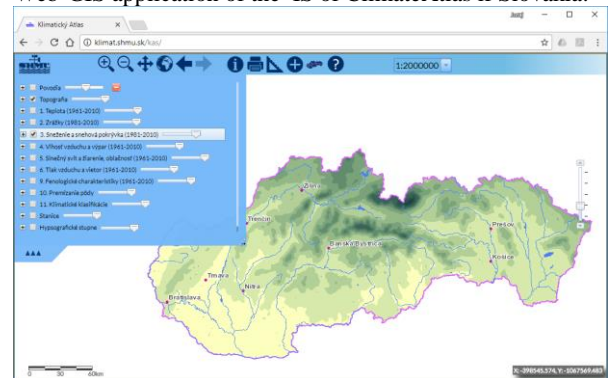
WEB-GIS APPLICATION OF THE IS OF CLIMATE ATLAS OF SLOVAKIA



Main functional offer represents the tool wich concentrates all the functions and functional modules. It can be divided to following basic categories:

- Basic displaying map functions
 - o Zoom, shift, addition of visualized data
- Getting the basic information
 - o Identification of the object enables to get attributed information
 - o Print
 - o Coordinates, length, area
- The content of the map - atlas
 - o Navigation according to the structure of Atlas
- Possibility to change the interpretation of the map segment according to the entered spatial criteria
- Creation of the queries - selection of the objects of the database (SQL Builder)
- Expert functionalities - statistics, interpolation services, mapping algebra

Web-GIS application of the IS of ClimateAtlas if Slovakia:



INTERACTIVE VISUALIZATION OF THE SNOW MAPS BY USING WEB-GIS APPLICATION

The application enables to display the snow data in following structure:

Snowfall

- Average annual seasonal number of days with snowfall
- Average monthly number of days with snowfall in November
- Average monthly number of days with snowfall in December
- Average monthly number of days with snowfall in January
- Average monthly number of days with snowfall in February
- Average monthly number of days with snowfall in March
- Average monthly number of days with snowfall in April
- Average seasonal number of days with new snow depth \geq 5 cm
- Average seasonal number of days with new snow depth \geq 10 cm
- Average seasonal number of days with new snow depth \geq 15 cm
- Average of seasonal totals of the new snow depth
- Average date of the first snowfall
- Average date of the last snowfall

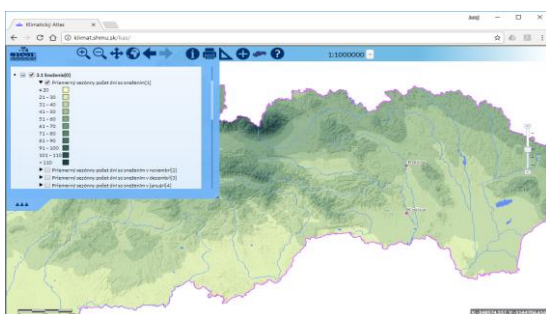
Snow cover

- Average seasonal number of days with snow cover
- Average monthly number of days with snow cover in November
- Average monthly number of days with snow cover in December
- Average monthly number of days with snow cover in January
- Average monthly number of days with snow cover in February
- Average monthly number of days with snow cover in March
- Average monthly number of days with snow cover in April
- Average seasonal number of days with snow cover depth ≥ 10 cm
- Average seasonal number of days with snow cover depth ≥ 20 cm
- Average seasonal number of days with snow cover depth ≥ 50 cm
- Average of the seasonal maxima of snow cover depth
- Maximum depth of snow cover at low elevations
- Maximum depth of snow cover at mountain sites
- Average monthly maximum of snow cover depth in November
- Average monthly maximum of snow cover depth in December
- Average monthly maximum of snow cover depth in January
- Average monthly maximum of snow cover depth in February
- Average monthly maximum of snow cover depth in March
- Average monthly maximum of snow cover depth in April
- Average seasonal maximum of water equivalent of snow cover
- Average date of the first snow cover
- Average date of the last snow cover

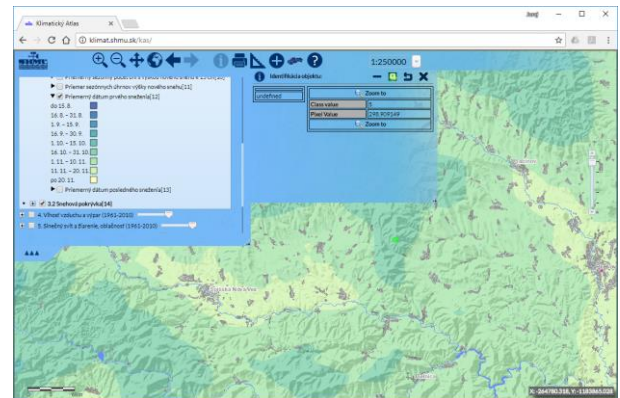
There are raster layers obtained by spatial interpolation from climate data measured at particular points (stations). The functionality of the application enables to visualize optional combinations and to compare them visually. In parallel, it is possible to obtain an accurate value of interpreted element or its categorization in any locality. The system also enables to display any available parameter, based on the administrative or hydrologic regions, for selected region or for part of the region. The application provides the overview of map services and layers from which are these components formed and enables to switch on or switch off the respective layer. The graphics legend can be displayed for each particular layer and the transparency of the map service can be changed. By dragging and dropping of map service in the module “Content of the map”, it is possible to change the sequence of the displayed map services. The respective module provides also the perspective of map items of the cartographic version of the Climate Atlas of Slovakia by using the map services following segmentation: service – chapter - group layer of the 1st level – subchapter - group layer of the 2nd level or of the layer – a particular map in the atlas. This way structured content of the atlas became a part of the module “map content” with all the functionalities, which are provided by this particular module. It is also possible to obtain on-line, in interactive process, the required information.

Some samples:

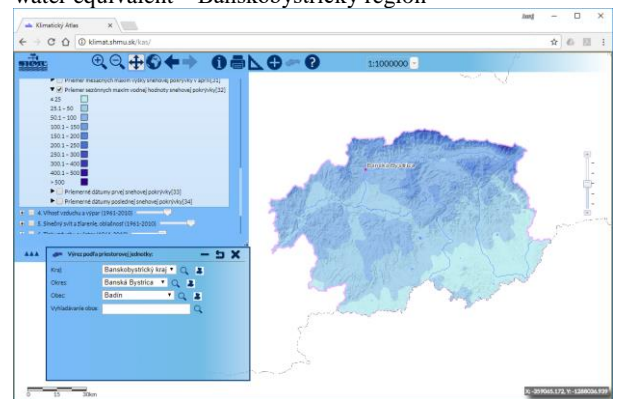
Map: Snowfall/ Average annual seasonal number of days with snowfall



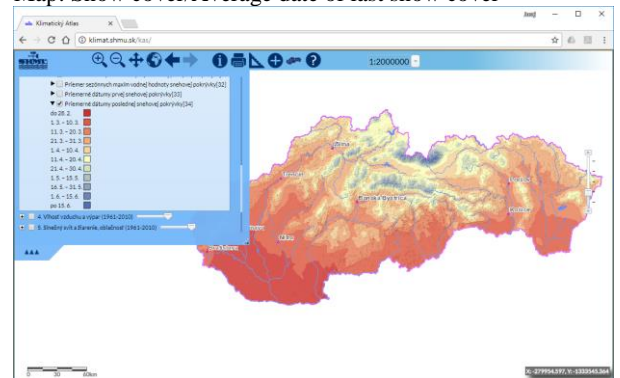
Map: Snowfall/ Average date of the first snowfall



Map: Snow cover/Average of seasonal maximum of snow water equivalent – Banskobystrický region



Map: Snow cover/Average date of last snow cover



Expert functionalities – statistics, interpolation service, map algebra

These functionalities are not available for the public and they require a certain level of the knowledge and technical skills. The module “Statistics and interpolation” is able to execute the selection of the data from climatic database by setting the data domain, time period, and set of stations. In case, when the statistical value is set, this is calculated from the selected data and the result is interpreted in the form of a table or in the form of graph. Further functionality offered by the system is the possibility to create an areal map by using the interpolation selected from the assembly of climate station/point based data (it works only for the whole country maps) being set by the user.

By setting the selected attribute criterion for monthly data (chapter – data domain – time period – cross sectional temporal selection) and for areal criterion, we can define a subset of data which we want process by statistical procedures (definition of the statistical parameter from the list) or to display it (in the particular table or in graphics). The module “raster algebra” executes mathematical combinations of the rasters.

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