EMaRT – possibilities for the use of innovative web technologies in monitoring of Natura 2000 territories

Elisabeth Weinke & Christian Ragger

[1] Interfaculty Department of Geoinformatics (Z_GIS), University of Salzburg, Austria
[2] REVITAL Integrative Naturraumplanung GmbH, Nußdorf-Debant, Austria

Abstract

A project of two years (2010-2012) entitled "Gathering basic information on habitats and species of collaborative interest in Austria" was announced by the 9 Federal States for implementing the Flora-Fauna Habitats Directive in Austria. A WebGIS tool called EMaRT (Expert Monitoring and Reporting Tool) was developed during the project in order to support long-term monitoring. EMaRT is an open source tool which was developed with 3 main aims: 1) to update habitat and species distribution maps and to ease the monitoring process of habitats and species, 2) to merge data in a central multi-user spatial database, and 3) to support the article 17 reporting process on actual distribution and evaluation of the conservation status of species and habitats to the European Commission. Data capturing, data management, data preparation, data processing and visualisation are big challenges for the projects with multiple users and a large amount of data. We discuss suggestions to solve these challenges in this paper. Based on the habitat with the FFH-Code 7240, it is shown how innovative web technologies were used in the project to solve these challenges and how these technologies can be used to update distribution maps, monitor and report data.

Keywords

WebGIS EMaRT, FFH-Code: 7240, distribution map, monitoring article 11, article 17 reporting

Introduction

A major goal of the Flora-Fauna-Habitat Directive is to conserve and restore biodiversity. This goal should be achieved by the development of the European Natura 2000 network of protected areas. The continuous monitoring of the implementation of the FFH-Directive and the documentation of the conservation status of selected habitats and species is an important component of the directive. All Member States of the European Union have to provide the results of conservation status for the European Commission with the so-called Article 17 report every six years. For improving the knowledge about habitats and species of community interest in Austria, a project of two years (2010-2012), entitled "Gathering basic information on habitats and species of collaborative interest in Austria", was announced by the 9 Federal States. The contractors are three landscape planning companies (REVITAL Integrative Naturraumplanung GmbH, freiland Umweltconsulting ZT GmbH, eb&p Umweltbüro GmbH), Interfaculty Department of Geoinformatics (Z_GIS) of the University of Salzburg and a group of external experts. In the project, 40 selected species and habitats of the FFH-Directive have been studied and the monitoring was prepared. The list of monitored species and habitat in the project covers almost all listed priority species and habitats of Austria in annex I and II of the FFH-Directive and all habitat types and species of community interest in annex I, II and IV, whose status was classified as unknown in the national report 2007 for Austria. For these species and habitats, distribution maps were updated during the project by using existing data and extensive field surveys. The future monitoring for these species and habitats of community interest was prepared according to article 11 of FFH-Directive. A description of the article 11 monitoring in Austria can be found in MOSER & ELLMAUER 2009.

For central and efficient data management of species and habitat in Austria, an open source WebGIS tool called EMaRT (Expert Monitoring and Reporting Tool) was developed during the project. EMaRT is an open source tool which was developed with 3 main aims: 1) to update habitat and species distribution maps and to ease the monitoring process of habitats and species, 2) to merge data in a central multi-user spatial database, and 3) to support the article 17 reporting process on actual distribution of data and maps of species and habitats to the European Commission. A description of the article 17 reporting can be found in European Commission 2013.

Nature conservation projects that manage a large amount of data and involve a lot of experts are challenging. Challenges can be found mainly in data capturing, data management, data preparation, analysis and visualisation (WEINKE & RAGGER 2012). We discuss suggestions to solve these challenges in this paper. Based on the habitat with the FFH-Code 7240, it is shown how innovative web technologies were used in the project to solve these challenges and how these technologies can be used to update distribution maps, monitor and report data. Discussed ideas from the project and expert workshops are presented in this paper.
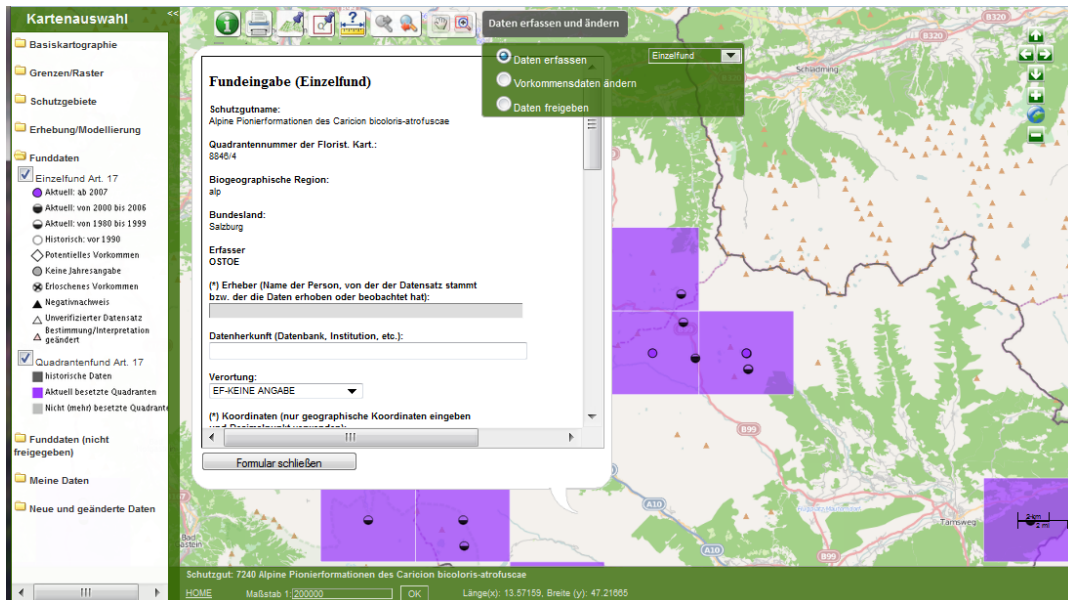
Figure 1: EMaRT-map viewer with an open online form. Single finds are visualised as points; Grid cell finds are visualised as filled quadrants;

Challenges

Challenges of managing a large amount of data and include multi users can be found mainly in visualisation, data capturing, data management, data preparation and analysis. These topics will be discussed in the following chapters.

Data visualisation

Even today in small and large nature protection projects all experts visualise data in a preferred geographic information system (GIS) on their own computer. In many cases, experts must transform data in needed coordinate systems or change data formats on their own. This fact requires at least basic knowledge in geoinformatics.

In the project a WebGIS map viewer was implemented to prepare a map viewer for specific requirements, datasets, tools and functions. The user can concentrate on data capturing and updating and do not lose time with data preparation problems etc. The map viewer can be used for four purposes 1) to get an overview of all data, 2) to prepare for mapping in terrain, 3) to get quick information of different datasets and 4) for data collection with a quality check. All habitat and species are visualised in its own map viewer. The map viewer includes general background maps and specific data of each habitat or species type. Background maps are, for example, the ÖK50, OpenStreetMap, the orthophoto service of GeoImage Austria, Nature 2000 areas, biogeographic regions and grid cells. Furthermore, specific data of each habitat (e.g. biotope mapping and modelling results for possible species distribution) are visualised in the map viewer.

Figure 1 shows the map viewer. The map viewer provides important navigation tools (e.g. Pan and Zoom), an information-button and scale tools.
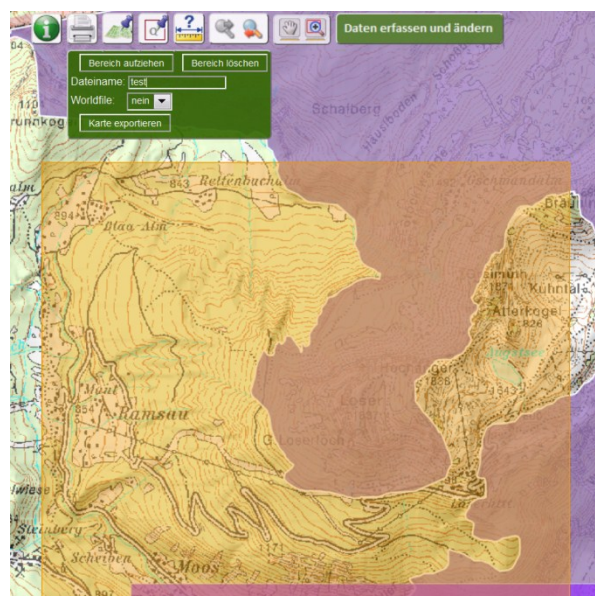

Figure 2: EMaRT Menu bar with open printing window

In addition, the viewer has a geoname search area, zoom functionality to the grid cells, a print function for fieldwork preparation, a tool to measure distances and areas and a tool for data capturing (see figure 2). For a detailed description of the data collection see chapter "Monitoring". Furthermore, the layer of content is shown on the right side, which can be turned on and off (see figure 1 left).

Data capturing

In national and regional conservation projects large amounts of data are recorded in different data qualities, formats and projections. This leads to the fact that datasets of different projects are incompatible and only with great effort data can be merged. In the project, data was collected through the digitization of geometries in a map viewer and / or by entering different parameters in online forms. All online forms include a date quality check before saving. All spatial data were saved in the coordinate system WGS-84. In the three processing steps (starting with update of the distribution maps till monitoring and reporting), data was collected in different ways. These different types are listed in the following subchapters.

Distribution maps – Data update

The distribution map was updated based on grid cell finds and single finds. Single finds are digitized as point geometries. Single finds which do not have an exact description of their location are aggregated. Aggregated single finds are visualised as grid cells with a centroid on the map. Grid Cell finds are often results of literature search. Such finds cannot exactly be located on the map. For each find, specific parameters have to be captured with an online form in addition (see figure 1).

Monitoring (Article 11)

For the monitoring of each habitat or species, specific methods were chosen. Therefore, a method for the selection of sample areas and a specific method to monitor monitoring-sites for fieldwork were defined. Points, Lines and Polygons can be digitized and updated in the map in the monitoring process. Depending on whether it is a sample area or a monitoring-site, different parameters can be captured. After digitizing a geometry, a form appears. The user can put in parameters and upload a photo. Additionally, existing datasets (e.g. inventory of biotopes) can be visualised for the digitizing process. Existing geometries of these datasets can be accepted and attributes can be defined. Figure 3 shows a monitoring-site and a sample area of habitat 7240.
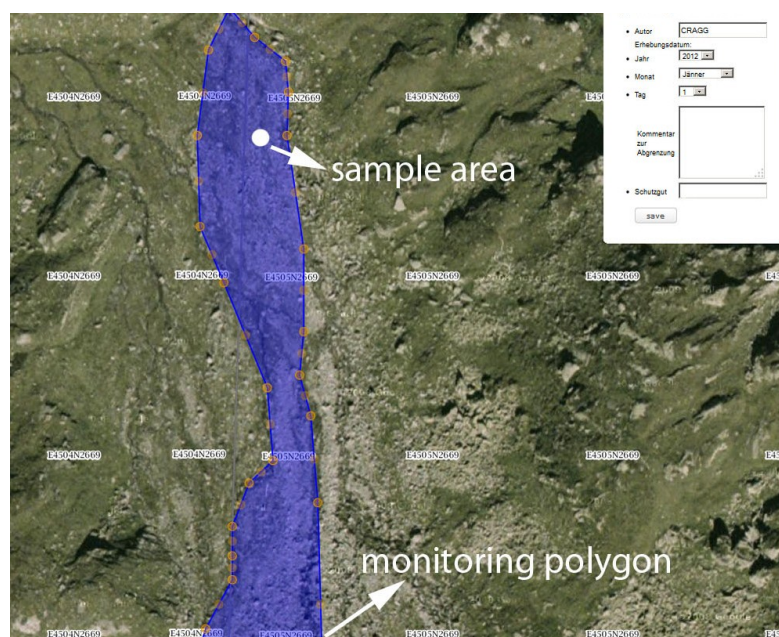

Figure 3: Visualisation of a monitoring-site and a sample area. Monitoring sites are visualised as polygons; Sample areas are visualised as points;

Reporting (Article 17)

To collect data for the reporting process a platform with online forms and data quality checks was implemented. Therefore the Access-Reporting-Tool of the European Union was implemented as web platform. In the reporting process just non-spatial data was captured. The reporting web interface contains the same parameters as the reporting tool of the EU (EIONET 2013). One advantage of the non-Access solution is that all data (monitoring and reporting data) are in the same database and queries can be easily done.

Data management

Even nowadays in nature protection projects data are usually stored and managed in various proprietary database solutions. In many cases, these are Access database solutions that do not allow central access to the current data sets. In addition in some cases, spatial and non-spatial data are managed still separately in databases. Many data are saved redundantly because of different data management solutions. Through this management of equal data in different databases a complete update of the data is nearly impossible.

In the project for data management a central, multi-user, spatial database was developed. Therefore, the data management system Postgres with its spatial extension PostGIS was used. The project is based on the monitoring

concept of the Federal States and the Federal Environment Agency (see MOSER & ELLMAUER 2009). In the year 2007 the Federal Environment Agency collected data and saved these data in an Access database. All datasets of this period were incorporated in the spatial project database. During the project, the data model was changed for saving and managing data of the 3 processes: 1) updating distribution map, 2) monitoring and 3) reporting. Background data and expert data (e.g. Natura 2000 areas) were either saved in files or in the database on a server. This data can be updated by authorized users with ArcGIS using ArcSDE. Recorded data of species and habitats can be updated e.g. with online forms in the web viewer.

Data preparation

Like visualisation of spatial and non spatial data experts normally preprocess all data in a geographic information system (GIS). In many cases experts must transform data in specific coordinate systems or change data formats on their own. This process is time-consuming, costly and error-prone and experts must have some basic knowledge of geoinformatics at least e.g. to correctly process coordinate transformations.

In the project, all data that are visualised in the map viewer are prepared in a standard format. Therefore, data are provided as WMS and WFS services. Data are published with Geoserver and are centrally provided on the server. During preparation process data were projected, error-treated and transformed in defined format. Complex and large Datasets were prepared as caches and were provided with Geowebcache as tiled WMS (WEINKE et al. 2012).
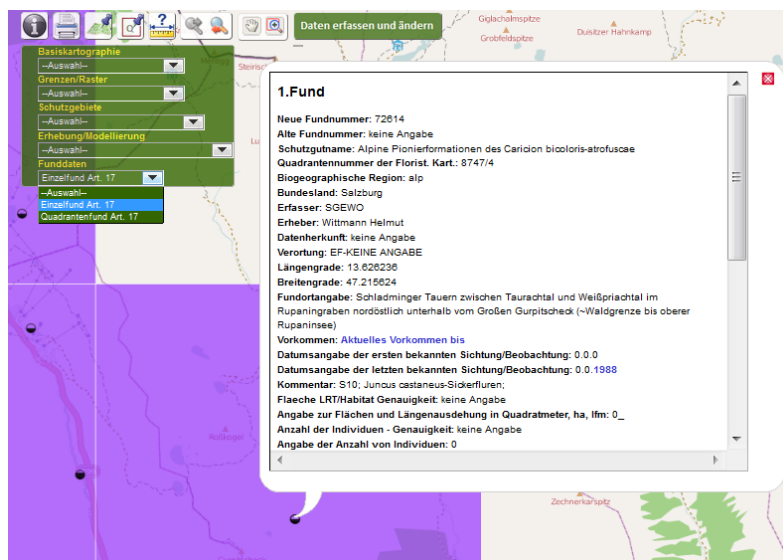

Figure 4: Information query of single find

Queries, data interpretation and data analysis

Usually the analysis of data sets is also carried out by each expert on its data resources on the local computer. Due to the single-user applications, the individual experts do not have the current datasets for data analysis. In EMaRT there are different possibilities to query data.

With the information button in the map viewer, the user gets current information of each dataset (see figure 4). All relevant information of the habitats and species (finding and distribution maps) can be exported and visualised via the web interface of EMaRT. Different criteria can be defined for the data queries and export. In addition, there is the possibility to export distribution maps in a PGN format (see figure 5). Reporting data can be exported in xml or html-format.
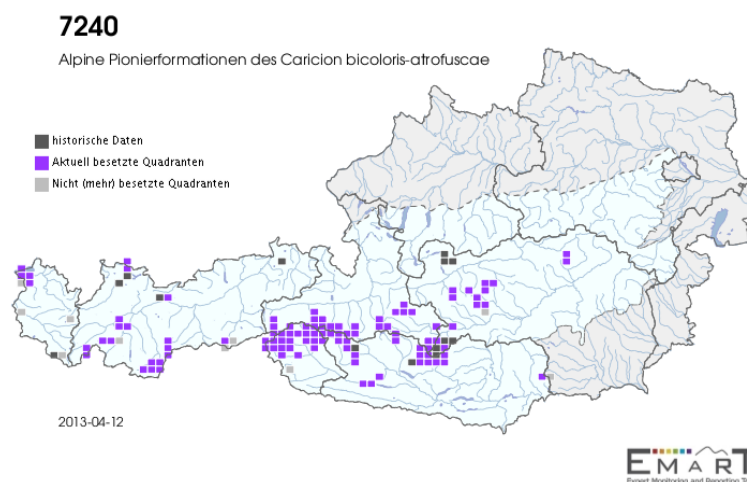

Figure 5: PNG-Export of distribution map of habitat 7240

Discussion

By visualising the entire data in a WebGIS map viewer, the entire database and actual data is available for each user. In the project, all data were prepared in a standard format by one project partner. Data were provided as Web map services. This saved a lot of time and costs in the data processing. All recorded datasets were saved centrally in a database; consequently, each expert has an overview of all data and actual recorded data of other experts. As a consequence, there was no danger that redundant data were stored. Data sets like Natura 2000 sites can be updated centrally. As a consequence, all experts and users can use the updated datasets after the modifying process. Another advantage of EMaRT is the multi-user access. All project partners and experts can use and collect data at the same time and have access to the latest distribution maps. Through online forms, a quality check of inserted data is possible to just allow accepted data and mandatory fields of the forms have to be filled out.

Conclusion

In this paper, we introduced the open source tool EMaRT. EMaRT was developed within a two-year national Austrian project and enables data collection, monitoring and reporting of protected habitat types and species in Austria. EMaRT allows managing a large amount of data in a central database and can be used from several users parallel. Because of the use of innovative web technologies, data visualisation, data capturing, data management and data analysis are not a big challenge in the EMaRT system. EMaRT enables an improvement of data quality because of quality checks of recorded spatial and non-spatial data. Data in EMaRT are centrally managed on a server; therefore, EMaRT provides improved availability and up-to-date datasets. In EMaRT, every user can see all data; therefore, the system has a high degree of data transparency. Through the use of EMaRT, the costs can be minimized because EMaRT e.g. provides a central data preparation and data availability, a central platform to capture data with quality check and each user can prepare its own printing maps.

A disadvantage of the online web platform is that users need to have internet access to capture data. In alpine and mountain areas, data recording is not possible. As a conclusion, the web viewer can be used to get an overview of distribution maps, for data preparation for field work and can be used to capture data if internet is provided. A combination of an online and offline mobile app would allow experts to capture data also in offline modus and synchronize data if internet is provided. EMaRT can be extended easily to other protected habitats and species. Also the number of parameters can be extended to record habitats and species with other requirements. In general a web tool like EMaRT could ease and improve the process of monitoring and conservation of habitats and species inside of Nature 2000 sites. An important fact is, that for nature protection, standards should be defined to ensure data quality and to enable rapid linking of databases of different projects. The availability of a central platform could help to standardise data capturing in the future for national and regional projects.

References

EIONET 2013. Documentation - Reporting formats for the period 2008-201. Available at: http://bd.eionet.europa.eu/activities/Article_12_Birds_Directive/reference_portal (accessed: 05/04/2013).

European Commission. 2013. Habitats Directive reporting. Article 17 reporting (progress report). Available at: http://ec.europa.eu/environment/nature/knowledge/rep_habitats/ (accessed: 09/04/2013).

MOSER, D. & Th. ELLMAUER 2009. Konzept zu einem Monitoring nach Artikel 11 der Fauna-Flora-Habitat-Richtlinie in Österreich. Endbericht. Wien.

WEINKE, E. & C. RAGGER. 2012. natura2000 goes2web: Möglichkeiten von innovativen Web-Technologien im Management von natura2000 Gebieten. netzwerk Land Tagung, Salzburg, Austria.

WEINKE, E., ASAMER, H., RAGGER, C., DRAPELA-DHIFLAOUI, J., GEWOLF, S., STÖHR, O., MILLER-AICHHOLZ, F., EGGER, G. & S. LANG. 2012. EMaRT - Monitoring. In: STROBL, J., BLASCHKE, T. & G. GRIESEBNER. (eds.): Angewandte Geoinformatik 2012, Wichmann Verlag, Heidelberg, 801-806.

Contact

Elisabeth Weinke
elisabeth.weinke@sbg.ac.at

Interfaculty Department of Geoinformatics (Z_GIS), University of Salzburg
Schillerstrasse 30
5020 Salzburg
Austria

Christian Ragger
c.ragger@revital-ib.at

REVITAL Integrative Naturraumplanung GmbH
Nußdorf 71
9990 Nußdorf-Debant
Austria