Cross-Border WebGIS Database CURe MODERN

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1 ABSTRACT

As part of the INTERREG IVa-research project CURe MODERN, a WebGIS-platform was developed, which enables a visual comprehension of studies done within the project. This project was realized in cooperation with the university of Kaiserslautern (TU Kaiserslautern), the Department of Computer Aided Design (CAD) & planning methods in urban planning and architecture, the Fraunhofer Institute for Nondestructive Testing (IZFP), the State Office for road construction in Saarland (LFS), the french associate CEREMA (Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement) as well as the Eurodistrict SaarMoselle and the company of Rogmann engineers from 2012 – 2014. Aim of the project was to use non-destructive testing methods for infrastructural and cultural buildings and to make these results available for stakeholders of the german and french side. As a kind of an infrastructural and cultural database, this platform aims to communicate results and experiences within the project as well as between the members of the project and also to politicians and citizens. It can offer policymakers a tool to quantify problems and to clarify where possible weak spots could be present for various buildings. With the integration of three dimensional models inside the platform, details such as the need to repair certain parts of the buildings can easily be shown to any interested citizen. This easy understandable platform was developed without the use of special expensive GIS-software. It was created as a browser based system and so it works with any common computer and helps with the communication between different disciplines.

2 INTRODUCTION

The problems of an aging infrastructure and the decline of cultural and historical monuments is not only a European problem, but even a global one. However, a cross-boarder region with various countries and planning mentalities offer a wide variety of solutions. This includes different legal regulations or interpretations of EU directives in combination with historically developed and matured approaches or solutions. The INTERREG IVa-research project CURe MODERN is targeting to use non-destructive testing methods for researching the structure of infrastructural and cultural buildings. In order to be able to show up the visual results of all researches, a special WebGIS based platform was developed for use within this research project. In order to reach this goal, four mayor goals are on the agenda (Kurz et al. 2014):

(1) The creation of a transnational network of specialized partners from the Saarland, Lorraine and Rhineland-Palatinate

(2) Implementation and application of new automated non-destructive testing methods, which were transferred in the corresponding services for monitoring of infrastructure works and cultural monuments in the region of Saarland-Lorraine-West Palatinate

(3) Use of methods and procedures for constructing 3D-models of selected objects in cooperation with local companies in the regional industry

(4) To give public authorities and municipal councils a tool for monitoring the state of their infrastructure, cultural and historical monuments with the construction of a cross-border database

3 THEORETICAL FRAMEWORK

For the implementation of cross-border monitoring of infrastructures and cultural buildings, various objects were analyzed with specific investigations for every object. The methods to visualize the gathered results need a scientific basis in the areas of WebGIS-development, 3D-visualization and the construction of geodatabases.

3.1 WebGIS-platforms as communication tools

In the light of technological developments, it is obvious that dynamic changes for spatial plannings are to be expected and planners can use ICT technologies for new ways of the planning process. Ubiquitous and pervasive sensors are omnipresent in the urban space and various sources of data could be used on the internet, from every place of the world. The diffusion of physical and real world will go on and a variety of planning tools will evolve (visualization tools, WebGIS etc.) which help planners with the communication process (Exner 2013). In the context, theory of Geoweb which shows the importance of the geospatial location of data (Herring 1994) will be crucial for the use in GIS for example (Crooks, Hudson-Smtih et al. 2014). GI-System are also seen as integral part of Planning Support Systems (PSS) (Geertman 2002). This is especially relevant, when content needs to be transported and communicated, for instance on complex planning issues such as with cross-border context, as it is part of the research project (Wundsam 2012). One approach are 3D visualizations, which put actors with different professional backgrounds target-oriented and effective in knowledge. To organize the relating content in terms of spatial data, the use of a Geographical Information System (GIS) is essential. Thus it was one aim of the project to create a tool, which combines the functionalities of a (Web-) GIS together with an easy accessible information platform on the internet. To build such a platform, on the one hand the complex requirements due to the heterogeneous databases have to be fullfilled and at the same time it must be easily accessible by policy makers.

3.2 Geodatabase

In order to be able to illustrate objects and informations on a WebGIS platform, all the data needs to be stored in a geodatabase. Therefore, the Open Source Database PostreSQL is used in combination with the Open Source Servertool Geoserver. By following a description of Streich, a database persists of three main parts of a geoinformationsystem. Further parts are the cartographic presentation and the geospatial analysis (Streich 2011 p.288)
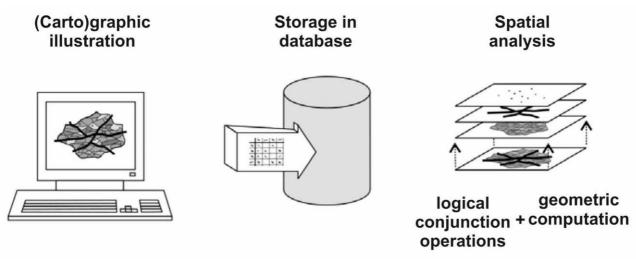

Figure 1: Components of a GI-System analysis (own graphic, based on: Streich 2011 p.288)

Due to PostgreSQL databases are not able to process spatial data to realize the database's georeference, an additional PostGIS-Extension will be required. While combining PostgreSQL with the PostGIS Extension, a spatial database can be defined, in which geometries and other data can be stored in tables (Mitchell, Emde et al. 2008 p.40). While using a geodatabase, collected informations and results of realized researches can be saved and afterwards get connected between themselves. The results can also be located on the deposited map, in order to achieve a clear allocation of the data. Therefore, threedimensional visualizations as well as detailed views of parts of the buildings can be displayed.

3.3 3D-Visualizations in WebGIS-platforms

In order to be able to present the results of the research project, all the buildings that were observed by non-destructive testing methods during the project were modelled in 3D true to scale. Especially in the content of urban and special planning, 3D-visualizations were seen as integral part of an embracing communication element within the planning process (Zeile 2010). This allows the users of the platform to localize the

researched spots and to show up the intensity of the damages at buildings. Software like Navisworks enables project review, integration and communication and has functionalities for the export of specific data, which can be visualized in WebGIS-platforms.
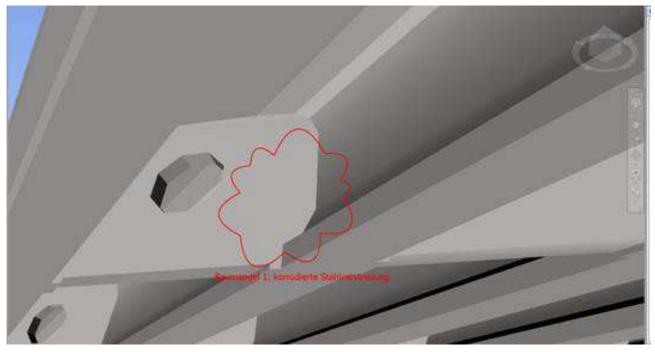

Figure 2: Screenshot from Autodesk Navisworks for vizualizing construction damages (Own source)

Usually 3D visualizations are used to transform complex issues to visual tangible 3D-models to be able to ease spatial comprehension of the circumstances. Especially for policymakers with a restricted expert knowledge of cross-border stakeholder constellations, this platform offers a simplification of the complex issues. As a consequence, the risk of a false localization of the structural damages will be possible to avoid. Therefore, it was part of the project, to build adequate exact threedimensional models of the object of investigation, which will be able to ensure engineering accuracy. But it also needs to stay manageable to be able to graphically complement object damages, as shown in figure 2.

Figure 3: 3D-model of the Mettnich bridge near Nonnweiler/Germany

4 IMPLEMENTATION OF THE WEBGIS-PLATFORM

In the context of the EU funded project CURe MODERN, it was a matter from the beginning, to develop a common database, which contains detailed informations of several infrastructural and cultural buildings. This database was supposed to allow all participants and even in a second stage the public, to recognize, what is the current state of each building and where researches are currently done. It also helps to get deeper insights to specific damages, while certain details of the buildings are threedimensional visualized. During the time of the project, it has been obvious, that the consumption of informations raised immediately. Therefore, the service was configured in the way, that a lot of information about buildings could be implemented with a very user-friendly user-interface. This also includes three-dimensional models, measurement results, pictures and construction maps.
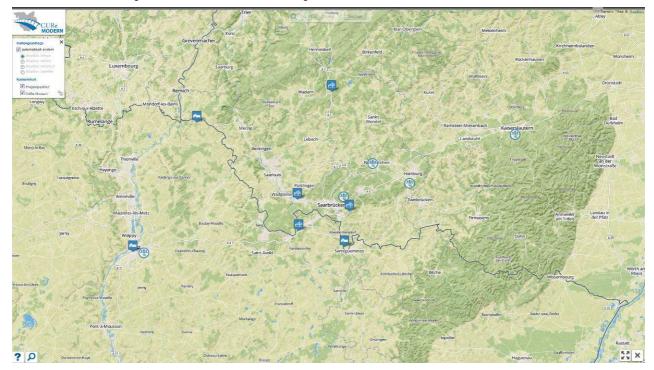

Figure 4: User interface of the WebGIS platform CURe MODERN (Own source)

4.1 Data gathering of non-destructive methods

The investigations were used in combination with specific non-destructive object testing methods. In addition to investigations conducted destructive threedimensional geo-referenced models were created of all researched objects. Then, both were implemented into the developed database. Within the geodatabase, it is required to store plenty of data. Simultaneously, the risk of redundancies needs to be avoided. Therefore, a dedicated structure is required and will be described following.

- All informations, which are directly related to the research object, just like a consistent object-ID

- A table, in which all relevant attachments will be collected, which relate to the research object

- A list in which all research results, that are connected with the test object, are saved. Thereby informations like name, status, costs, priority, damage classification, time period and arrangements will be stored

- A table, which is related to the attachement of the researches. These are able to be get filled up with multiple data formats to reach extended informations

The information range of the tables is modular expendable and it's possible to add more required attributes. In this context, it's important to be able to add new attributes into the user interface. At the same time, backup-tables will be arranged, which are required for the repair function, to avoid undesired cancelations of research objects. The required database relations will be accomplished by the object-ID and are the basis for accessing the database. This refers to all four existing tables, to offer the users a widespread and structured overview about the research object.

In the context of the project, the region of Saarland, Rhineland-Palatinate and Lorraine/France was checked for representative objects and case studies, which were eligible for the researches with non-destructive methods. At this point, just a few significant examples were adduced to show up the function of the testing methods. Subsequently to each measurement, the task was about to link the gathered data with an acquired 3D-model. For that case, it will be possible for the viewer, to allocate the inspected damaged part exactly, to be able to recognize the part on site later on the building. Beyond that, all inspected buildings are located in an online map, to submit a spatial coherence of the research object. So, the connection between the researches and the results were possible to show up visually in order to be able to offer municipial policymakers a base for the guidance. With this guidance, further approaches will be able to decide.
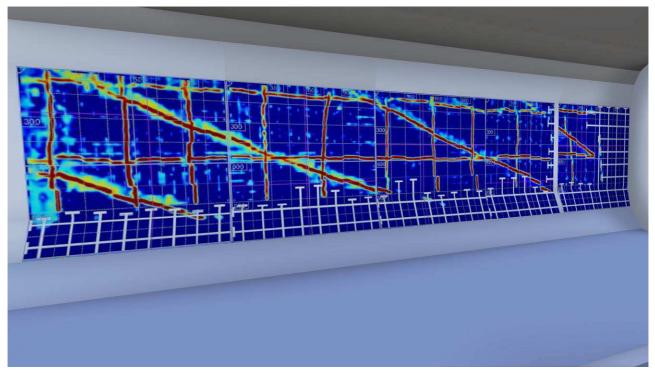

Figure 5: Generic detailed view of a infrared scan inside the bridge of Rosbruck/France (Own source)

4.2 Functionalities for communication of the platform

The configuration of a planning and communication platform is connected with several challenges, from which all required functionalities can be extrapolated. On the one hand, there's the management of the geodata and on the other one the modular usage for the cross-border project group. As described previously, the web-based geographic information system contains a variety of functions. The user interface has a selection of different cartographic bases, which includes a terrain map, two different street maps and a satellite map. A selection by the user can be made on every zoom level. Furthermore, a search function is also available for all research objects and testing investigations. The map contains relevant informations concerning the project partners as well as indicators to the type of study objects with a distinction between infrastructural and cultural buildings. The database even contains the following additional information about the buildings:

- Name of structure
- Specific details as text
- Year of construction
- Thumbnails
- List of tests
- 3D-models
- Other project-related documents, such as plans or detailed pictures

The study list of an object can have multiple entries and can be edited by the user independently. Other attachments can be added at this point. The entire WebGIS-platform can also be adjusted to the erespective needs. By selecting the respective investigation, a new window with additional damage details containing the following points can be implemented:

- Name of the investigation
- Priority (low, medium, high, none)
- Status (pending, taken, completed)
- Costs
- Damage class
- Period of tests
- Type of measure
- Preview image of an examination

It is possible to record the costs of the specific testings and damages in order to visualize these amounts online within graphs in a time period. It also allows therefore a monitoring of testing methods in terms of the financial capacity for specific projects.
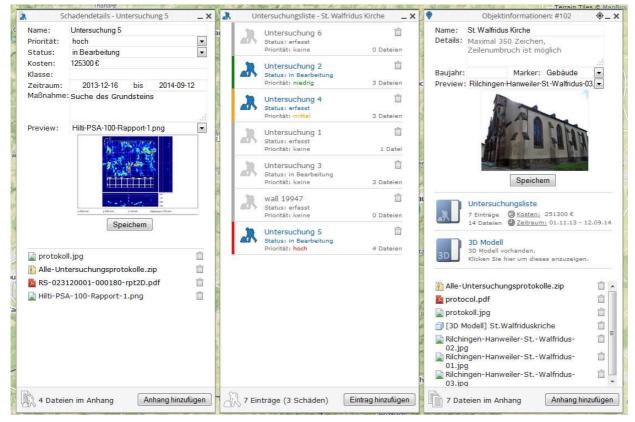

Figure 6: Object informations, investigation list and damage details (Own source)

Another focus of the developed WebGIS is on the ability to visualize 3D-models. To achieve the best possible usability, the use of widely accepted standards was important in the project. Hence, the format

3D-PDF is used to embed the visualizations into the website, also with previously selected fixed viewpoints. However, it is also possible to freely navigate within the 3D-model.
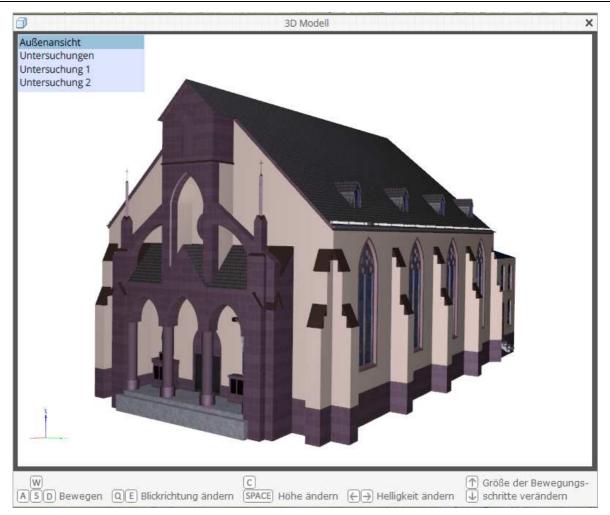
Figure 7: 3D-model with a detailed view to the researched parts inside the building (Own source)

The platform enables scientists and policymakers to combine geolocated studies and visual results of various. This link offers numerous advantages for planners and the planning process arise (Kebbedies 2013 p.13). The illustrated WebGIS platform especially provides planners a flexible and open instrument, which can be used for planning-related solutions. Main focus for the project was that each project participant has a tool which enables them to view current conditions and examination of buildings. Hence, it should also serve policymakers to easy present a current status reports to committees and easily to draw attention to special issues.

5 SUMMARY

As part of the funded INTERREG IVa-project CURe MODERN, a network of specialized partners from the Saarland, Lorraine and Rhineland-Palatinate was established. The combination of structural inspection by non-destructive testing methods for monitoring and damage diagnosis with a WebGIS platform is a novel approach, that enables new planning opportunities and a flexible exchange of information in the cross-border context. The WebGIS platform in the CURe MODERN project provides the basis for a cross-border cultural database that allows to manage and visualize different objects and their associated tests. It is important to build a common database in order to ensure the best possible cooperation between different actors in a cross-border area. The aim of the project, to use sensory non-destructive testing methods and to make this information available on a larger scale for spatial planners, was achieved. The merged information and test results may be useful both for internal communication, presentation and mediation for the local decision-makers. By the use of a WebGIS, no additional software is needed and an access from a standard installed browser is possible. Through the use of open source software, a free and flexible approach could be achieved. Though, the disadvantages has to be considered as well. The custom-made WebGIS is accompanied with the usual problems of a prototypical implementation which includes individual aspects in terms of the stability.

For cross-border cooperations, the EU funded project "CURe MODERN" represents an enormous importance, because the variety of partners from different regions, countries and disciplines is exemplary for many European regions. Each partner has its own background, which has to be bundled in the context of the project. Thereby, the preparation of the communication platform can only be seen as a first step to more integrated solutions. This is particularly important for the European spatial data infrastructure. Comparable solutions as to be constructed corresponding to the INSPIRE Directive (Infrastructure for Spatial Information in the European Community). Furthermore, technical advancement in the context of mobile devices to host such platforms will go on. In addition, it is considered a fundamental point, especially in such complex themes, with an embracing constellation of actors to initiate further cross-border cooperation projects, to be prepared for upcoming emerging transnational issues in the context of infrastructure monitoring. In conclusion, the EU funded project is a great success, because many damages on significant buildings were inspected and the members of project were able to work out action requirements to obtain most of the research objects. The demonstrated WebGIS platform was even able to show up policymakers the urgency to act on making decisions concerning about special buildings in order to obtain them. In one case, the inspection revealed, that a building need to be rebuild, so the construction work will start soon.

6 ACKNOWLEDGEMENT

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