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Quality of Information Collected with the Help of Map-Based Questionnaires

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1 ABSTRACT

In this paper we concentrate on the geoinformation collected with the help of an online map-based public participatory platform. The platform was implemented within the EU project SWITCH. It represents a novel approach in combining online questionnaires and interactive online maps. The developed map-based public participatory platform was implemented for the case study of Wilhelmsburg, which is a city district in Hamburg, Germany. In our research we focused on the technical architecture of the platform and the issues of geoinformation quality collected with the help of online map-based questionnaires. Different measures of geoinformation quality related to our case study are presented and discussed. We conclude the paper with a discussion of the results and further research directions.

2 INTRODUCTION

Decision makers in urban planning need information about the interests and needs of the people living in a certain area. In the past they often used analog questionnaires and field analysis in order to collect this information. This can be an appropriate method if the information can be collected in a form of a text or in a discussion with the inhabitants. However, the majority of the urban planning issues are related to a geographic context. If urban planners wish to collect the opinions of the inhabitants related to geographic context, they have to provide analog or digital maps. The inhabitants can than express their opinions about the environment in which they live; they can draw points, lines or polygons to mark locations, routes, or objects. Later all these maps containing the opinions of the inhabitants have to be analyzed by the urban planners. They can help them to make better decisions about planning issues including the wishes of the inhabitants. In such a way expressed opinions can be migrated to a geoinformation system (GIS) which provides functions for their spatial visualization and analysis. This migration can result in a substantial effort invested by GIS experts who have to enter and interpret the objects drawn on the map. Possible errors occur within every interpretation. This process also requires additional time and effort of a skilled personell and is therefore costly for urban planners.

We are interested in an approach that would enable the inhabitants to enter their wishes and opinions directly into a computer-based system. This solution would enable to avoid the costly process of additional entering the information into a computer-based system and the process of interpreting the data. In our research we concentrated on the following two research questions: 1. Can we create a platform based on Open Source software which will enable to combine online questionnaires with online interactive maps? 2. Will the quality of the information entered online by the inhabitants satisfy the accuracy needs of the urban planners? In order to work on the research questions we designed an online map-based public participatory application. In this application we included online-questionnaires for the collection of opinions and wishes of the inhabitants. The questionnaire was combined with interactive maps which included some editing and drawing functionalities. The platform is still accessable under the following address: www.wilhelmsburgamwasser.de.

This research was done within the EU project SWITCH, which is the name of an action research programme, implemented and co-funded by the European Union and a cross-disciplinary team of 33 partners from 15 countries around the world. It aims to bring about a paradigm shift in urban water management away from existing ad hoc solutions to urban water management and towards a more coherent and integrated approach. The vision of SWITCH is for sustainable urban water management in the 'City of the Future' (Switch, 2011). Within the project we were responsible for the execution of a public participatory process in Willhelmsburg, Hamburg. The platform enabled the citizens to provide information about their spare time activities in Wilhelmsburg with the focus on the use of the water bodies. In the design of our interactive map we aimed at enabling the interaction as simple as possible. We had to assume that most of the participants were not familiar with interactive maps or GIS-based technologies. We needed to address as many inhabitants of Wilhelmsburg as possible in a very short time. The duration of public participatory process was one month

and we collected information in a digital format from more than 52 inhabitants. Additionally to that, we collected opinions of the inhabitants in our field studies. We managed to collect responses from additional 66 inhabitants. In this article we present some of the results and concentrate on the quality of the entered information and description of the technical characteristics of the platform.

This article is organized as follows. Chapter 2 overviews the case study in Wilhelmsburg in Hamburg and presents our research focus. Chapter 3 shows the implementation of the map-based public participatory platform and the technical architecture of the platform. Chapter 4 discusses the measures of geoinformation quality used within the project. Chapter 5 concludes the article with a discussion about the results and further research directions.

3 CASE STUDY AND RESEARCH GOALS

The main focus of the case study was on the use of water ressources in urban water management. The case study was already defined by the EU project SWITCH and our collaborating partners. We concentrated our research on a selected city district Wilhelmsburg in Hamburg, which includes water bodies and a natural preservation area. The case study and our research goals are described in this chapter.

3.1 City District: Wilhelmsburg

The city district Wilhelmsburg is located on the south of the city Hamburg, across the river Elbe, and close to the harbor of Hamburg (Fig. 1). It is surrounded by the docks and waterways as well as by the river banks of the river Elbe. Several areas of Wilhelmsburg are below the water level of the river Elbe which results in many drainage channels being part of this area. Some of the river banks, especially on the south, belong to the natural preservation areas. In these areas the flora and fauna have been protected and may interesting birds and other species have found their place of living here. These protected areas neighbour the areas which are available to the citizens for their daily recreational activities.

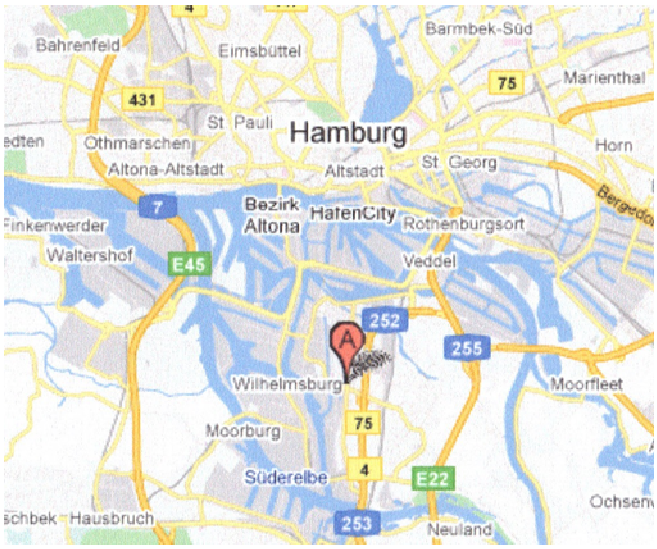

Figure 1. Case Study in Wilhelmsburg (© Google – Map data © Tele Atlas)

In our case study the urban planners focused on possible conflicts between the recreational use and the nature protection in the neighbourhood areas. In this city district, different stakeholder groups are active including those who aim at protecting the water bodies and the nature around them. Other groups, for example families, might be interested in sports and want to use the water bodies for their recreation. Some citizens like to gather and enjoy barbecue, jogging, walking along the water bodies, or even use them for their recreation in a kayak or canoe.

3.2 Project Goal: Online Public Participatory Platform

The main goal of the project was to analyse the situation in Wilhelsburg and collect the wishes and opinions of the inhabitants. The opinions were mostly related to the current use of the water bodies and their wishes for the possible future use. In order to do this, we decided to implement web-based technologies and support the public participatory process with a map-based platform available online. Our task was to develop an

online platform which would enable to collect citzens` opinions entered directly on a map. These opinions would further on help urban planners to understand the situation in this city district and possibly solve potential conflicts between the protected areas and those planned for recreation.

The online platform should provide the same possibilities as a traditional method based on a paper questionnaire and a paper map. The citizens should be able to answer questions written in a text form and select an answer from a list of possible options. One of the goals was to combine a questionnaire with maps on which the citizens could possibly draw lines or points. The maps should be available online as an interactive platform where the citizens could zoom-in and zoom-out and be able to use some basic functionalities. They should be able to draw points and lines representing their favorite places, prefered bicycle and walking routes, etc. In this way they would be able to provide geographically referenced information in a digital form.

The public participatory platform designed should also be easy to understand, user friendly and designed in a way that different citizens can use it in an intuitive way. An additional requirement was to design a platform based on Open Source software in order to reduce the cost for the project participants and the citizens of Wilhelmsburg.

3.3 The Role of Urban Planners

Within this project the urban planners had a wish to understand the interest of different stakeholders and the inhabitants living in Wilhelmsburg. There is a possibility of conflicts among the stakeholder groups interested in the natural protection of some areas and the inhabitants who wish to user the water bodies for their spare time activities. In our project the urban planners needed an overview over the needs and wishes of the people who live in the district Wilhelmsburg and are interested in the recreational use of the water bodies. They had to understand the main patterns of behavior related to the current use of the water bodies. Beside, they were interested in the wishes of the people related to the future use; what would the inhabitants like to change? How should the future use of the water bodies be organized? This information would allow them to recognize the tendencies and categorize the water bodies according to their current and future use. It would also help them in their discussions with the nature protection stakeholders and in their decisions about the planned protected areas.

3.4 Our Research Focus

In our research we focused on the creation of a public participatory platform based on Open Source software. The main technical requirement was to integrate classical online questionnaires with interactive online maps. Online map-based questionnaires are a novel research area. One of the first experiments with online map-based survey was done by Al-Kodmany (2001). His research was based on the theory provided by Lynch (1960) and Nasar (1998), who emphasized the importance of discovering how city design affects citizens. Another study was done by Sidman et al. (2005) who used an analogue map-based questionnaire that has been conducted by mail. The aim of the study was to “acquire spatial and behavioral information that can be used to characterize and map on-water recreational boating activities and use-patterns” (Sidman 2005). In contrast to our approach in which we are interested in integration of an online questionnaire with intereactive maps, he used analogue questionnaires.

In our research we focused on two sets of research questions. The first set was related to the implementation of the technical requirements. They included the following research questions: How can online questionnaires be integrated with interactive online maps? How can we gather accurate information given by the citizens and drawn on a map? How should online maps be designed in order to enable a pleasant interaction and also encourage the citizens to contribute their opinions? The second set of research questions delt with the quality of the information entered online by the inhabitants. What is the quality of information entered by the citizens? How can we analyse the quality of information entered online by the inhabitants? Can the entered information and its quality satisfy the accuracy needs of the urban planners?

4 ONLINE MAP-BASED PUBLIC PARTICIPATORY PLATFORM

In order to answer our research questions we designed a technical architecture of the online map-based public participatory platform. We implemented Open Source software in order to make the solution available for free to the citizens of Wilhelmsburg and to the urban planners. This chapter describes the entrance page,

the interactive maps included in the platform, its technical architecture and the software used for the implementation.

4.1 Entrance Page

The entrance page of the platform is designed in a rather simplistic way. In the middle of the entrance page the participant can find the instructions for the interaction with the maps. They include the description of the buttons integrated directly on the map (Fig. 2). The user can immediately see the example of a map and get used to its look and feel. On the left side, there are the following three main buttons: Home, Information, and Contact. The questionnaires combined with maps can be accessed under the description of the map functionalities.

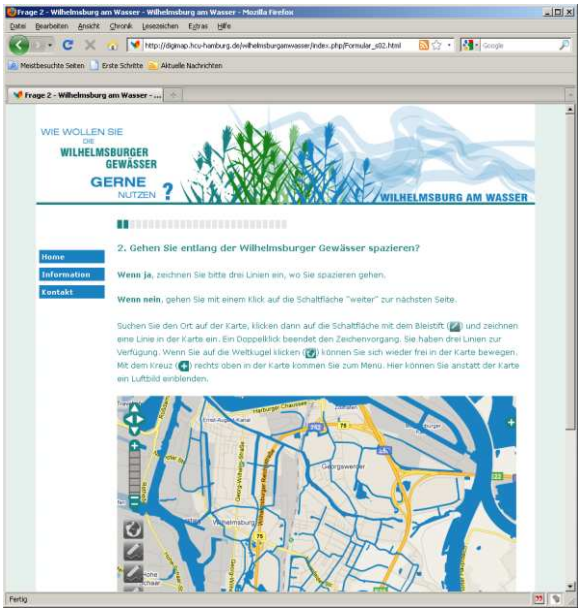

Figure 2. The entrance page of the map-based participatory platform (www.wilhelmsburgamwasser.de)

4.2 Interactive Maps

The maps included in the map-based public participatory platform are interactive, which means that the participants can interact with them. The participant can construct up to three geometries on each of the included maps. Enabled types of geometries are points or lines. The icons representing three pencils (Figure 3) indicate that the participant can draw up to tree lines on each online map. In order for them to be able to interact with maps, we designed two different modes. The navigation mode enables basic navigation and the edit mode enables drawing lines or points on the map. If the participants want to draw a point or line, they have to change into the edit mode. Each geometry includes its own edit-button. In order to change back to the navigation mode, the participant has to press the navigation-button.

We used OpenLayers for the implementation of some standard navigation functionalities such as zoom and pan, and for editing geometries on the map. OpenLayers can display geographical data from all common geodata sources such as Google Maps, Bing, Yahoo, Open Street Map as well as data from WMS- or WFS-servers and many other sources. As we wanted to address as many people as possible and as most people are familiar with Google Maps, we decided to use the data from Google Maps as a background for the interactive map. We decided to use the standard Google Street Map and the Hybrid Map, which is a combination of the street map and the orthophotograph. Geographical data of the water bodies and the river Elbe were integrated as an overlay on top of the maps from Google Maps (http://maps.google.de/maps). The different data sources are also shown in a map legend where the participant can switch on and off the different layers.

Figure 3. The interactive map based on Google Maps (© Google Maps)

4.3 Technical Architecture

The online map-based public participatory platform was implemented by using Standard Web 2.0 technology. Figure 4 shows a diagram of the architecture of the web server connected to the client. As a platform for the server we used the virtual system VSphere from VMWare Global, Inc. The system enabled us to host a virtual server independent from the hardware. As an operating system we implemented the Linux-System Ubuntu 10.04 LTS (Lucid Lynx). As a HTTP-Server we used Apache from the Apache Software Foundation.

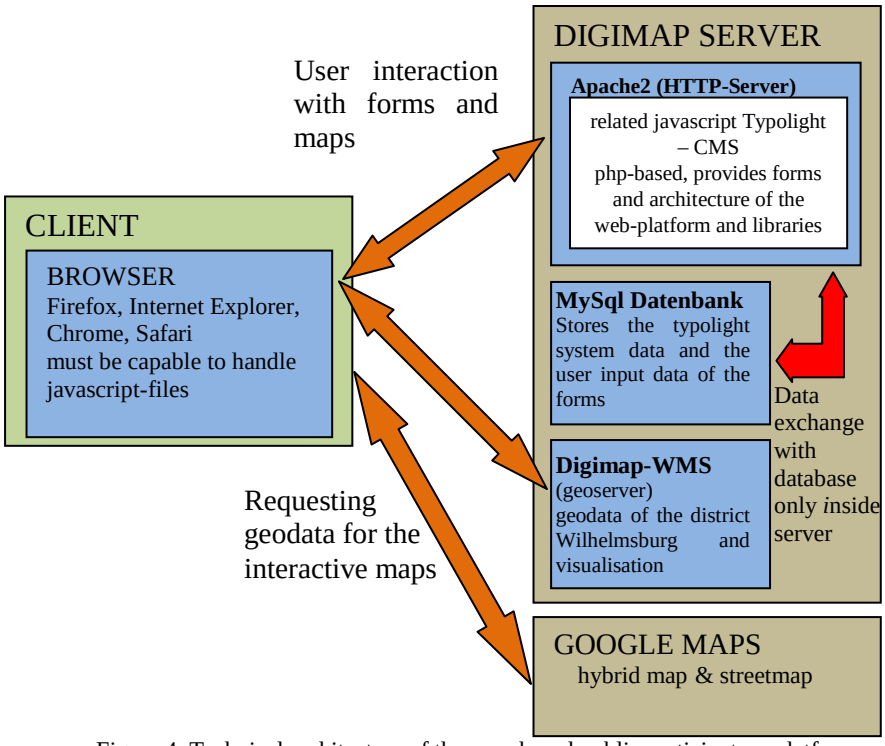

Figure 4. Technical architecture of the map-based public participatory platform

In order to provide the maps in a fast and effective way we decided to use the Open Source Web-Map-Server geoserver from the Open Source Geospatial Consortium. The WMS geoserver was hosted on the same server system as the HTTP-Server and the PostgreSql database. The WMS-server provides the geographical data as rendered raster data tiles which get rendered automatically on demand. When the user presses the “next”-button he goes on to the next question and the form inputs as well as the painted geometries are transmitted to the http-server where they are passed to the MySql-database.

We implemented the content management system (CMS) Typolight 2.8. This gives the public participatory platform and the users a high degree of user confidence and comfort while using it. The questionnaires were

embedded in the CMS. Typolight 2.8 is an Open Source CMS and is shipped with a form support. The form support of the CMS did not include a support for interactive maps. Therefore we used the Open Source Javascript library OpenLayers to develop the interactive maps. The interative maps were embedded in the forms of Typolight using the html-formfield-support of Typolight. As a database we use MySql 5.0. There is no direct traffic between the client and the database. All data from the client is send to the http-server and afterwards transported to the database by Typolight. This means that the client does not need a permission to access the data in the database. The client does not need to know the login data for the database. All communication with the database is done between Typolight and MySQL. This enhances data security.

4.4 Execution of the Public Participatory Process

In order to address a heterogeneous audience we used the university mailing list as well as mailing lists from the stakeholders in the district of Wilhelmsburg. In addition, we combined the online questionnaire with an analog questionnaire which was provided to the people in the district by the interviewers. In this way we could address an audience that included people from a wide spectrum of the district. Due to our restricted resources of time and money we were not able to collect responses from all inhabitants of Wilhelmsburg. The online platform was available online for one month. The opinions of the inhabitants of Wilhelmsburg were entered with the help of the designed map-based public participatory platform described in this chapter. We managed to attact 52 inhabitants with the help of online questionnaires and 66 through our field work. The opinions gathered in the interviews on the analogue maps were later entered into the database with the help of the map-based participatory platform. We combined the results gathered from the digital and analogue public participatory processes.

5 MEASURES OF GEOINFORMATION QUALITY

The information entered with the help of the online platform contained some errors. We realised that we have to pay a closer attention to the issue of information quality. We analysed the information quality of the collected information according to several measures. In this chapter we list only some of the most important measures. Their applications and the consequences for the urban planners need additional research.

5.1 Completeness of Geoinformation

The urban planners, who have to make their decisions based on the collected information, are interested in the reliability of the information. The relation of the information completeness and the quality of decision taken by the help of this information is very important. Turner (2002) and Zielstra and Zipf (2010) studied completeness. According to Turner (2002) “completeness is defined as the degree of which information is missing”. The less information is missing the higher the information completeness. He demonstrates the needs of data quality completeness for road and traffic data. This data is often used in case of emergency management and completeness of the dataset plays an important role in the efficient rescue activities. It is important to have a complete map of all streets and their attributes so the algorithm can result in the shortest routes suggested to the police or fire department. In this way they can reach their destination as fast as possible. Fessele and Poplin (2010) studied decision quality on a study case of a car navigation in an unknown city and focused on the information about one-ways streets. In our case, the completeness of the citizen’s opinions was improved with additional information collection. We collected information on an analogue map with the help of the field work in the city district of Wilhelmsburg. This possibly resulted in an improved information completness which can enable the decision makers to get a better overview over the wishes and opinion of the inhabitants in the selected city district.

5.2 Positioning Accuracy of the Geometrical Elements

Figure 5 shows the situation of the Spreehafen in Wilhelmsburg and the neighboring roads and walkways. The originally red lines (black on Figure 5) demonstrate the geoinformation collected with the help of the platform. They show the walkways preferred by the inhabitants of Wilhelmsburg. The entered lines are often not situated precisely on the roads or walkways.

Figure 5. Drawn foot walks: The positioning problem (left: background map © LGV Hamburg, right: areal image © Google Maps)

In order to understand the reasons for this positional inaccuracy we would need to invest into some additional research. We were not able to determind whether the participants understood how to zoom in and get a more detailed view. It is also possible that they did not want to take the time to zoom to the detailed map level. In some cases this imprecision of the entered information caused some difficulties in the interpretation of the street or walkway the inhabitants wanted to mark on the map.

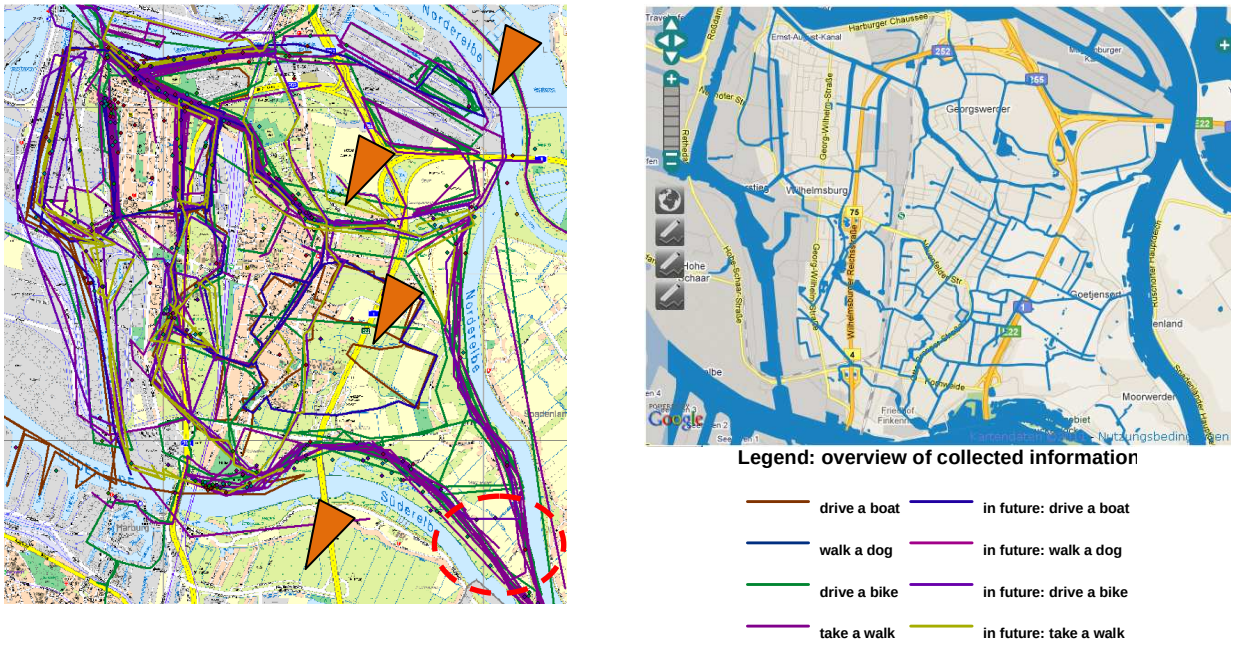

Figure 6. left: overview over the collected data (background map © LGV Hamburg), right: the inital view of the javascript map (background map: © Google Maps)

Wilhelmsburg is a rather big district in Hamburg. In order to be able to mark longer routes on the interactive map, the participants have to to switch between the navigation- and editing mode.The elements shown in the ellipse on Figure 6 (left) indicate that the participants had problems understanding and using the navigation possibilities of the interactive map. These elements are drawn along the map border. We assume that the participants wanted to draw the lines along the street in an area which is not shown on the initial view of the map. To do so the users had to navigate on the map before they changed into the edit-mode. We assume that many participants did not understand this switch between the different modes or they estimated it to be to time consuming.

The tri-angle markers on Figure 6 indicate the elements which are not related to any content of the map. We assume they were drawn by users to test the edit mode. Elements like these have to be deleted before the collected information can serve as the base for an analysis done by the urban planners. Additional research related to the participant‘s experiences is needed in order to understand the information entered with the help of the online platform.

5.3 User Dimensions of the Quality

Who are the participants that entered their opinions and habits with the help of the online map-based public participatory platform? How long was the platform online and how many participants entered their opinions? Is this the opinion of the majority? Exel, Dias et al. (2010) discuss the quality of the users with respect to the impact of crowdsourcing on spatial data quality. They suggest the following three components of the user quality: local knowledge, experience and recognition. They call them the users` dimensions of the quality. In our case study, not only the quality of the single users should be discussed, but also the quality of the audience. As you can never address the complete audience it is good to address a heterogeneous group of the audience. A heterogeneous audience provides the decision maker a heterogeneous view of the wishes and opinions. As the quality of the decision is not only a matter of the completeness of information, but it is also related to how this information has been collected.

6 CONCLUSIONS AND FURTHER RESEARCH

In our research we designed a unique online platform that supported public participatory process in Wilhelmsburg, a city district of Hamburg, Germany. Within this platform we integrated web questionnaires and interactive maps and offered them online. The citizens of Wilhelmsburg could use it; express their opinions about the current use of water bodies and their wishes for the future. Map-based web questionnaires were a helpful tool for the collection of information. This information can potentially help urban planners to improve their decisions about environmental changes and possibly prevent conflict situations.

The design of the online map-based public participatory platform was a challenge. There is no standard tool available which would help us to create the interactive maps. As there are varying requirements in different projects, the development of the interactive maps is a process which has to be accomplished for every project in a unique way. There are many possibilities to combine questions which have to be answered by drawing an object and answers which have to be answered in the form of a text. Interactive maps are an appropriate tool in projects involving planning tasks that concern many people. In smaller projects involving a lower number of participants, discussions and interviews with paper questionnaire combined with paper maps are appropriate.

A profound analysis of the information entered with the help of the map-based platform and its quality is need. Additional research has to be invested into a better understanding of the appropriate user interface and the interaction of the participants with online maps. From the information entered with the help of the online platform it is not possible to conclude why the participants entered sometimes meaningless information and sometimes information that it difficult to interpret.

Currently we work on the design of a usability study which will give us additional information about the participant’s perspective and the usability of the platform for the variety of different possible users. In our study we will focus on the usability of the designed interactive maps, the usability of the two different modes, and the basic functionalities. We will test the zoom-in and zoom-out functionalities trying to understand how many users would use such functionalities in an intuitive way. The results of the usability study will also help us to design and implement an improved, even more intuitive map-based public participatory platform.

7 REFERENCES

Al-Kodmany, K. (2001) Online tools for public participation, in: Government Information Quaterly 18, pp. 329-341.

Exel, M. v., E. Dias, et al. 2010. The impact of crowdsourcing on spatial data quality indicators. GIScience2010.

Fessele, M. and A. Poplin 2010. Statistical anylsis of routing processes using OpenStreet Map road data of Hamburg with different completeness of information about one-way streets. GeoValue 2010. Hamburg: 87-92.

Lynch, K. (1960) The Image of the City. Cambridge: MIT Press.

Nasar, J. (1998) The evaluative image of the city, Thousand Oaks, CA: Sage.

Sidman, C., Swett, R., Fik, T. and Sargent, W. (2005) A Recreational Boating GIS for Sustainable Florida Waterways, in: Proceedings of the 14th Biennial Coastal Zone Conference New Orleans, Louisiana, July 17 to 21, 2005.

Switch. 2011. EU Project Website, http://www.switchurbanwater.eu/ (accessed: 1.2.2011).

Turner, S. (31.12.2002). Defining and Measuring Traffic Data Quality, Batelle,Texas Transportation Institute Cambridge Systematics Inc. Office of Policy Federal Highway Administration Washington, DC.

Zielstra, D. and A. Zipf. 2010. Quantitative Studies on the Data Quality of OpenStreetMap in Germany GIScience2010. Zürich.