

# Maps as Decision Support Tool in Political Decision Processes

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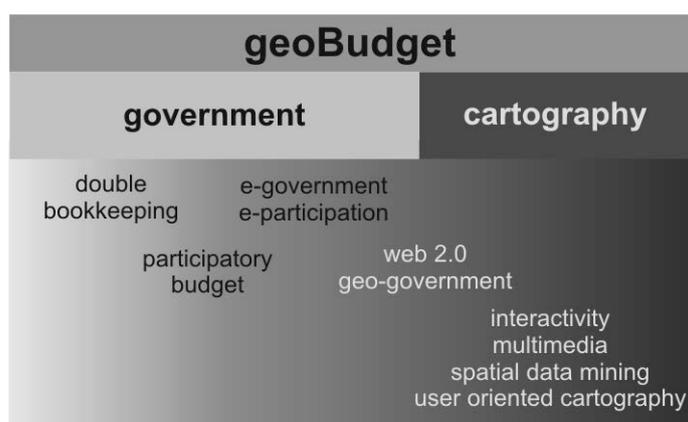
**Abstract.** The research project “geoBudget” maps the expenditures of a local authority in order to show decision-makers the spatial impact of their actions. The question (departing from the cartographic action theory) is, if decision-makers at local level are interested in the spatial dimension and if yes, to which extent it plays a role in their decision making. Furthermore, the aim of the project is to compare different types of maps in order to show how local politicians can be supported best. The research methods are an online survey and an eye tracking study. The results are very heterogeneous. The participants can be divided into two groups: one group generally is interested in the use of maps, the other group shows no interest. The general interest has more influence on people's answer behavior than other factors (e.g. actor groups, age, experiences).

**Keywords:** Spatial Decision Support, Eye Tracking, Cartographic Action Theory

## Introduction

Every year, local authorities in Germany decide about the planned expenditures for the next year. City councils, residents and members of the local authorities discuss how the small amount of money can be used in the most efficient way. As a member of Trier city council my starting point for the research project “geoBudget” was that space just doesn't seem to play any role in the decision taking process. Therefore I wanted to find out if space is really not a decision criterion for the actors or if the existing information materials just don't respect the information needs of those finally taking the decisions. The idea is to map the local budget. Mapping budgets exists in other applications. Wermker & Heil (2003, p. 257) see the necessity to find spatial organization schemes for local budgets. The authors argue that the administrative reform has to be complemented by a spatial dimension, in order to be able to get positive developments in poor neighborhoods. Jun-

kernheinrich & Klemmer (1985) deal already in the 1980s with the spatial efficiency of public finances. They analyzed the labor market areas in North Rhine-Westphalia. Having a look at the local scale, approaches of mapping budgets exist in the local community budget Berlin-Lichtenberg. In Bezirksamt Lichtenberg von Berlin (2006) the general acceptance of the relevance of the spatial dimension to budget decisions led to first examples of a spatial repartition of the local budget. But a complete georeferencing of a local budget is still missing. Therefore the aim of the research project geoBudget is to create an interactive cartographic decision support system in order to show the relationships between spatial developments in towns and the local expenditures.



**Figure 1.** The project geoBudget within actual research topics.

## Objectives

The project geoBudget is embedded in the action stage and action-situation oriented approaches of activity theory. The actors are embedded in a network of components which influence their decisions. Furthermore, an action can be split into several stages, according to the formal system of establishing a local budget. Those stages can be combined with cartographic action fields according to Bollmann (1993). The most relevant cartographic action fields within the process of establishing a local budget are cartographic information processing and spatial communication. Bollmann & Koch (2001) additionally differentiate the operations which can be led with the presented spatial information. The three operations “discriminate / classify” (which condition has a special object?), “compare” (where are objects, which correspond with the condition of a special other object?) and “pattern discovery” (are there substantial relationships between objects in a special region?) can be combined with both cartographic action fields. It isn't possible to measure the impact of a map in an action scale of the local budget, but it is possible to investigate the maps when different operations

are performed. These operations are in use during the establishment of the local budget in different intensities, depending if a stage needs more (one-sided) information transmission or spatial data mining.

Having georeferenced the local budget, the main question of the research is if the question “where” plays an important role at all in political decision processes. Andrews (2007, 161) notes that “Policy decisions should be rational but sometimes they are not.” Werlen (2010) discusses the ability of actors to generate power from the control of spatial relationships. The first question is if actors at the local scale are aware of this spatial power. If yes, the second topic has to demonstrate if the spatial aspect can be a useful decision criterion by using maps. And as maps can have many different faces, in a third step, it should also be proven which map type is appropriate in which information retrieval context.

## Methodology

In order to map the local budget, it first has to be georeferenced. For those who never had to work with a local budget just let me explain in some words how it normally looks like: a bulk of paper, with lots of numbers, many of them zeros. Every expenditure has a title, which sometimes explains quite comprehensive what exactly will be done; in other cases, the title could hide quite diverse activities; especially, the question “where” can in most of the cases not be answered by just reading the local budget. Instead, the employees of the local authority had to explain the meaning of every single expenditure. Money which is spent e.g. in constructing buildings can easily be mapped. But all expenditures e.g. in the social domain go to people. They are living at a particular address. Therefore, if the address is known, it can be georeferenced. As the local authority of the city of Trier has a decentralized IT-organization, data was delivered in many different formats as well as in printed versions instead of digital data. This made the georeferencing of such address data very time consuming and finally limited the project to parts of the budget instead of taking the whole budget into account.

The first part of the empirical research was an online survey. The link was exclusively sent to the members of the city council, members of the local authority who are involved in the local budget and citizens who are registered for the community budget platform. 314 people replied. The aim of the questionnaire is to identify crucial aspects which are influencing decisions, peoples' spatial knowledge and their attitudes towards map use. In a second step, respondents, who gave their email-address voluntarily, were invited to an eye tracking experiment, in order to get objective information about which map type suites the user needs best and to ask deeper questions about the cartographic information preferences of the respondents. The results of the questionnaire and the eye tracking studies can be linked

via a personal code. Therefore, the eye tracking results can be analyzed within the three actor groups (defining themselves as belonging to the local administration, the citizens or the local politicians), age groups, experience with maps and IT and knowledge about local budgets.

The experiment was performed on two Windows workstations connected via VPN client, one running the Tobii eye tracking software Clear View, the other one running the web-based questionnaire with integrated maps including logfile registering. The questionnaire was displayed on a 17-inch flat screen at a 1024\*768 screen resolution. Eye movements were recorded with a Tobii x50 eye tracker, at a 60Hz sampling rate.

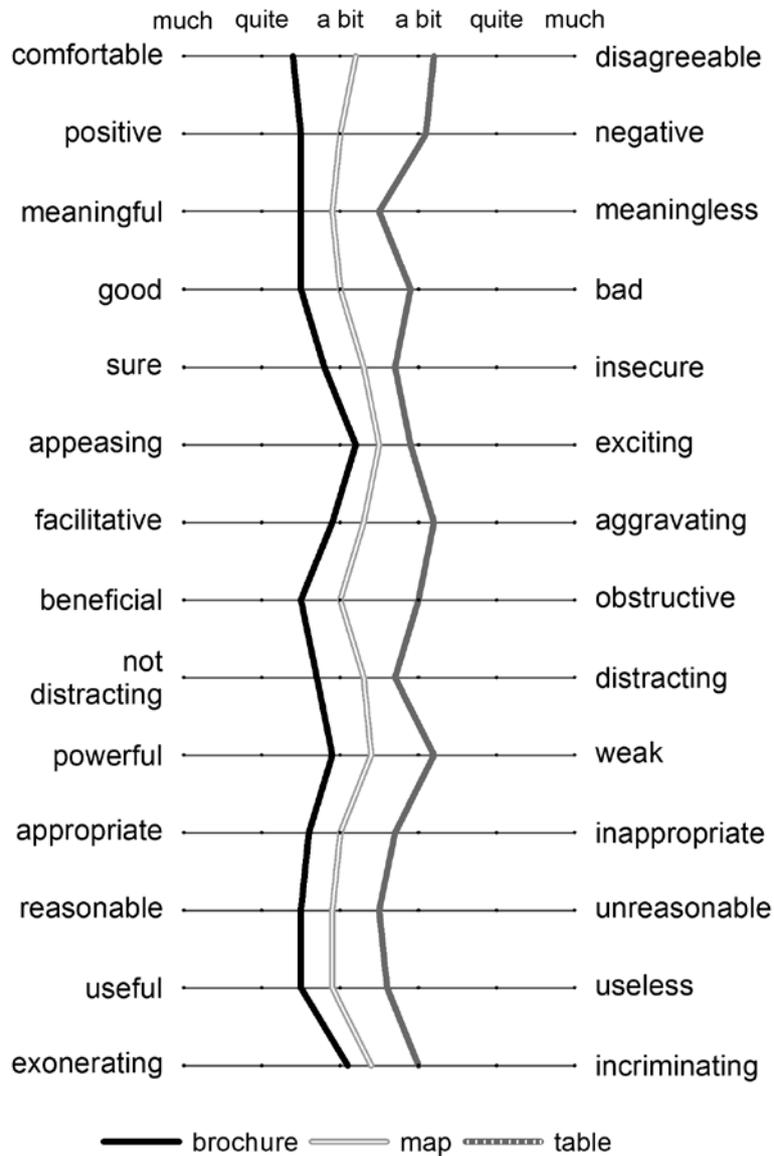
## Results

Table 1 shows part of the results regarding the first research topic. The respondents could choose several options. It can be seen that the three spatial items are placed as third, fourth and fifth item. The respondents were also asked several other questions, and the tendency is quite obvious: space seems to play an important role for the three actor groups, but there is no difference between the actor groups. Other factors, like experience with the local budget, seem to be more important for decision making than belonging to one of the actor groups.

	Percent of Responses
Creating new situations through investments	67,7%
Experts' opinion	66,0%
The city district for which I think the investment is useful	62,2%
The city district where I live	44,2%
My personal relationship to a city district	25,5%
The opinion of friends and family	18,0%
Preserving city districts in the current state	17,0%
The opinion of political parties which I belong to	14,6%
Other items	10,6%
The opinion of political parties which I don't belong to	4,4%

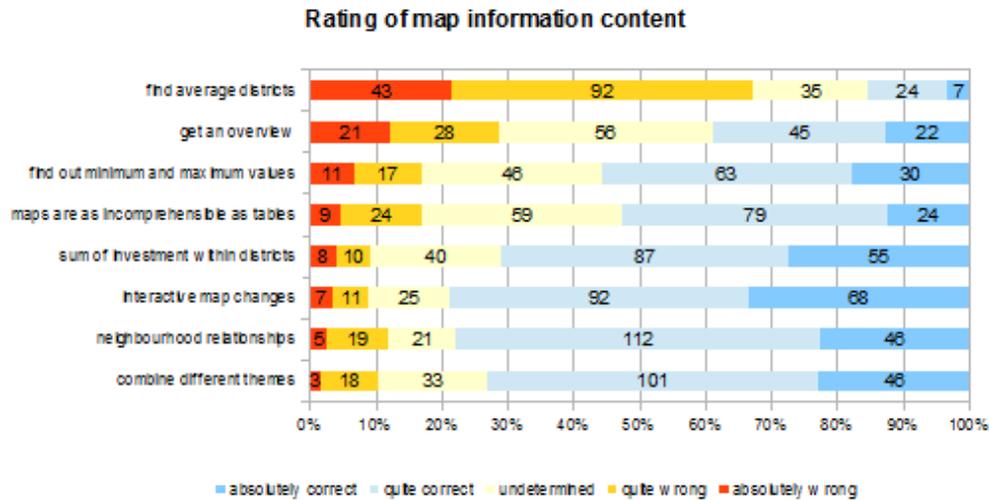
**Table 1.** What influences decisions about the local budget.

Comparing the three media table, brochure with texts and diagrams with maps respectively, the result using the semantic differential technique (figure 2) is quite obvious: within all items, the table is considered worst, whilst the brochure is considered best. The map is situated in between.



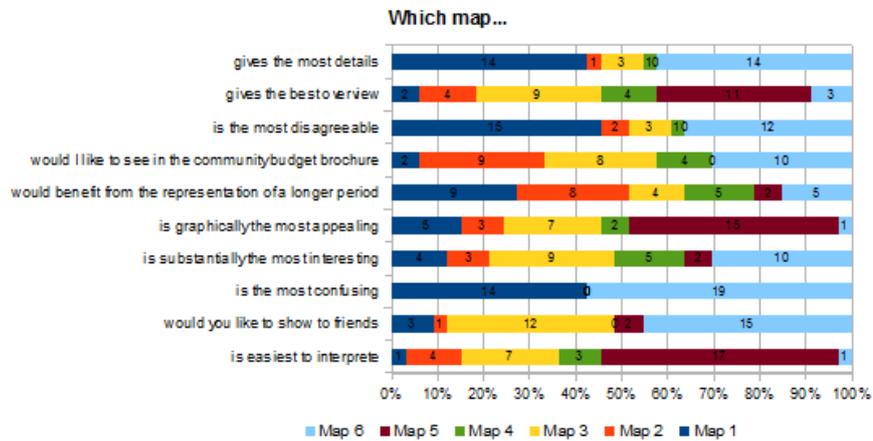
**Figure 2.** Comparison of brochure, map and table with the semantic differential technique.

Being asked which tasks could be well established with maps (*figure 3*), the highest agreement can be seen with the operations „combine different themes“, „neighborhood relationships“ and „interactive changes“.



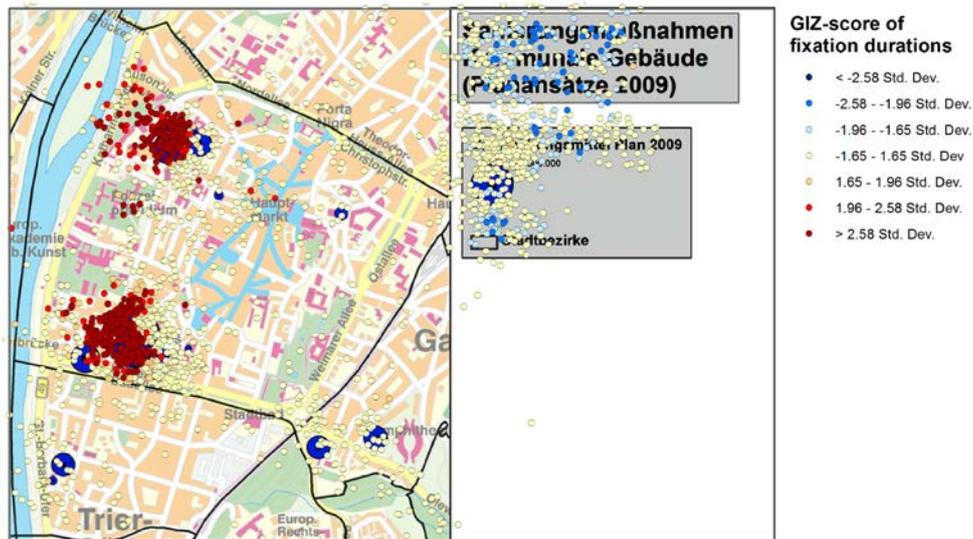
**Figure 3.** Operations in maps.

The 33 participants in the eye tracking study were shown six maps which were differentiated in the map types (choropleth maps, diagram maps), the color scheme (bipolar or monochrome) and legend representation (numbers or text). Being asked which of the six maps suits best to different items, the results shown in *figure 4* were reached. They contain some results which seem, on a first view, surprising as similar complex maps (maps no 1 and no 6; no 1 showing the provenance from children in different kindergartens, no 6 showing the state of the road network and actual investment plans) are both judged as „not pleasant“, but whereas no 6 seems to be worth being shown to other people, no 1 is not. My interpretation of this discrepancy is that the interest in different maps is essentially conducted by the map theme: no 1 showed kindergartens, no 6 the road network investments. At the time of the research, the bad state of public roads was a big theme in the local newspaper.



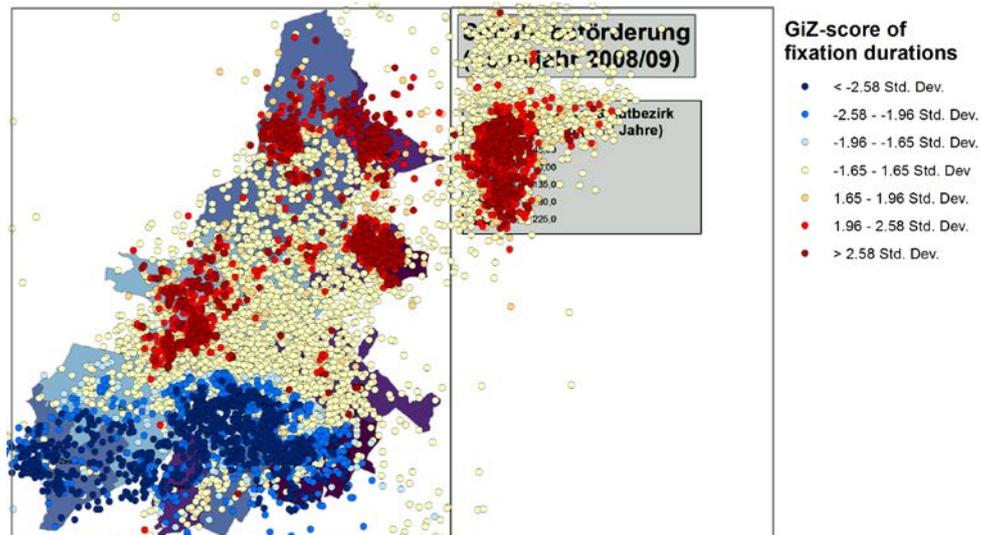
**Figure 4.** Comparison of the six maps.

Seeking for hot spots within the fixations of the six maps, the results were very heterogeneous: map no 2, showing proportional dot symbols (*figure 5*) shows a clear pattern of fixations. The red dots show significant high values of fixation duration, the blue dots significant low values. The two regions in the map with the biggest dot symbols were the most fixated areas.



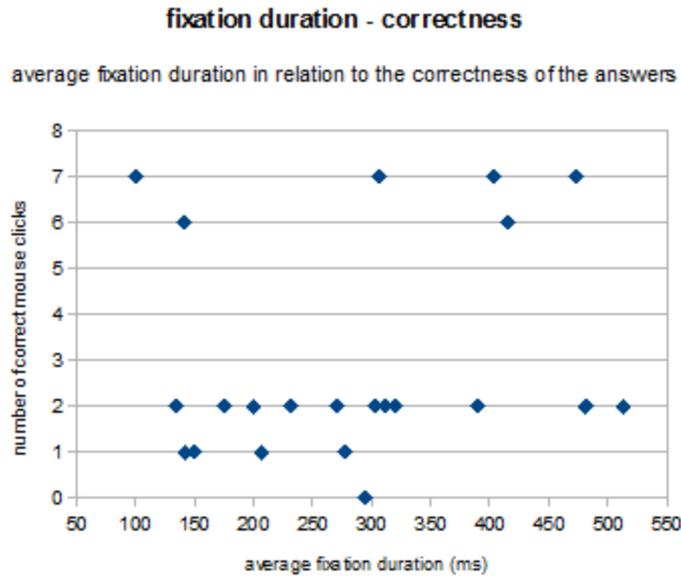
**Figure 5.** GiZ-score of fixation duration in map no 2

Figure 6 shows another pattern. Map no 5, a monochrome choropleth map with numerical legend, shows significant high values on the legend, as well as different areas in the map. Totally, there were much more fixations than in map no 2.



**Figure 6.** GiZ-score of fixation duration in map no 5

In eye tracking literature, the question whether the fixation duration can be interpreted in a way that longer fixation durations mean more intense information processing is not answered yet. Holmqvist et al. (2011), Holsánová (2008) and Irwin (2004) discuss different aspects of the parameter fixation duration. Figure 7 shows that in the eye tracking study, no correlation between the fixation duration and the correctness of the answers can be proven. The same is valuable for the average fixation duration, and for all maps used in the study.



**Figure 7.** Correctness and average fixation duration.

## Discussion

The results from the online survey show that the respondents have a general interest in the spatial dimension when asked about their decision behavior during the local budget establishment. But there is no clear answer towards the rating of maps. The answers are not significant in respect to the three actor groups, nor are there any relationships with the age of the respondents, the duration of the occupation with the local budget, the frequency of internet use or digital map use. It seems that there is a group of people who just like maps and visualizations. This group appreciates the presented maps and gives detailed hints about what would be still more helpful for them in order to take well-informed decisions about the local budget. The eye tracking study reveals that the fixation patterns are more heterogeneous the more complex the map is. It seems that the qualitative answers from respondents are more useful in constructing maps for spatial decision support than the quantitative eye tracking data, as maps with similar complex visualizations get quite different judgments when respondents are asked about their attitudes towards the map. One reason for different judgments could be the general interest in different fields of politics. This means that further research should be done and the compared maps should all come from the same field of politics in order to be able to really compare them.

## Conclusion

I could show with the first results of the project geoBudget, that the answer if a local budget can be presented as map can be generally answered with "yes". The quality of the georeferencing depends on the input data from the local government. Space is an important factor of local budget decisions and the respondents who have an positive attitude towards maps give also positive judgment about user oriented cartography as decision support tool.

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