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## GEO POLL - Integrate Cartographic Questions in Web Forms, Polls or Surveys

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**Abstract:** Most of the web forms, polls or surveys are composed with classical input fields (check boxes, radio buttons, select lists, etc.) and a lot of standards web forms builders or services (e.g. Typeform, WuFoo, Google Forms, Survey Monkey, etc.) help to build and deploy them. Nowadays, offering a text area to catch a ZIP code or a select list to point out a country remains the best way to explicitly collect geospatial data. But what about mapping interfaces to integrate cartographic questions and/or cartographic answers as a more suitable solution? How to let form's respondents indicate in which area(s) they engage in certain activities? The only way to solve these issues is by coding it yourself. This paper shows the design and technical problematic and try to give some solutions to build an efficient UX for the respondents and a standard answers treatment for the data analysts. This paper will also highlight the capacities of open source JavaScript library like OpenLayers to build the solution. Our interface was tested by the cities of Lausanne and Pully (Switzerland) and thousands of people answered to these cartographic forms on mobile and desktop. We would like to share some good practice and lessons learned.

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## 1. Introduction

This article reflects the development of two surveys made for the municipalities of Lausanne and Pully in Switzerland. Indeed, the planning department and the political representatives of these two cities in the French-speaking part of Switzerland have launched some initiatives whose aim is to involve citizens in the decision-making processes related to future developments of their territories.

In one case, the city of Pully wants to give a new face to its city center (Pully 2017). Previous experiences have proven that the rearrangement of a city center is a sensitive subject, this is why, late 2015, the municipality decided to conceive a public consultation. The target audience for this consultation were the inhabitants, the workers and the other users of the city center. In the second case, starting from 2015, the city of Lausanne is renewing its train station as the travelers flow will double by 2030. This will impact the surroundings and their users. The city wanted to make a public consultation were the travelers, the workers and the neighborhood residents can participate to rethink the train station surroundings (Lausanne 2017). For both cases, people were involved in multiple activities like workshops, conferences, debates, paper and web surveys.

## 2. Problem Definition

In urban planning, what is commonly referred to as a "participatory initiative" intensively uses tools or methods of implementation of many kinds: public consultation, seminar, workshop, interview, exhibition, etc. Even Pully and Lausanne municipalities are already used to publish various online surveys with the dedicated tools or providers available on the market (e.g. WuFoo, Google Forms, Type Forms, JotForm, Survey Monkey, etc.) which have greatly contributed to democratize this type of actions. However, given that issues related to urban planning are closely related to the people and activities in spaces of various scales, they are usually not easy to grasp as soon as we use the traditional input types that make up web survey forms (radio buttons, check boxes, lists, sliders, text, etc).

It is then obvious that techniques from user-generated content have to be considered, especially from VGI (Volunteered Geographic Information). As an example, when it is about a citizen science project (Haklay 2013) which requires contributors to collect data about biodiversity (Ingensand et al. 2015), a cartographic user interface is essential. In other words, the map is always at the heart of the solution. This is also true for the projects with Pully and Lausanne municipalities and the kind of surveys that was required. The literature shows that many design aspects of web forms have been explored of which Bargas-Avila et al. 2010 does classify the design in five topics: form content, form layout, input types, error handling, form submission. If guidelines to improve efficiency, effectiveness and user satisfaction have been defined for classical input types like checkboxes, radio buttons or drop-down menus, the case of using cartographic user interface as another input type has never been investigated. In a way, both demands coming from the municipalities were the opportunity to consider them as case studies to push forward the design process with the map "just" as a new generic input type of a form. It is to introduce a new type of question in a survey, the cartographic question that involves an interaction with a map. In the following, we describe some essential aspects of the design process from which we extract some guidelines.

Also, the following requirements and technical specifications had to be considered:

- surveys developed for the web, in other words, no native source code to manage;
- responsive design so as to reach and satisfy the greatest number of potential users;
- single-page mode, so that respondents can immediately evaluate how long is the task to fill in the survey.

### 3. Cartographic Questions?

When it comes to geographic data in a web form, we can think of postal address input fields. Usually, they are text fields or drop-down lists (for example, to choose a country). Using predefined directories of the possible values, auto-completion can make the task of answering the question easier or more efficient from the user's point of view. The more advanced interfaces provide at most a way to indicate an address by clicking on a map and using reverse-geocoding to get the underlying address, but this type of service is by far not very widespread.

In our case, respondents are asked to answer questions about their activities inside a urban space and how they perceive this space. For example:

- Where do you live? Where do you work?
- What use do you have of this area?
- In your opinion, where is the city center?
- Etc.

Some of the expected answers have a perceptual nature, they are all strongly related to map areas the respondents are aware of and should recognize because they often visit them. Therefore it seems obvious that the use of a map is more apt to collect such expected answers. But what are the issues to consider to design a cartographic question ?

First of all, it is important to think about the content of the expected answers according to the different points of view, like:

- the analyst: what is the level of precision expected, for what use or for what analysis?
- the respondent: who would agree to give the precise address of her/his employer, or her/his exact home address? How long will it take to respond? Who is smart enough to define the rigorous perimeter of a city center? Can everyone read a map?

Then, in term of interaction design, even if the collected geographic data are most often at the neighborhood level and because the territory concerned may be relatively wide (at the scale of a city), the interface must certainly offer the standard functionalities that allow navigating a map (zoom, pan).

And for the main issue, that is about how to collect the answers, two approaches are worth to be considered: input by drawing and input by selection.

#### 3.1. *Input by drawing*

For this approach, the answer is a "portion of territory" which is supposed to be digitized by the user. After an analysis of all the cartographic questions related to our two case studies, it shows that four types of spatial entities may be possible answers, that is with: a point, a circle, a polygon area, or a scrawled area (drawn freehand). Indeed, none of the considered questions could expect a linear object as a response.

The approach by drawing manually the response is interesting as it gives the greatest freedom to the users. The design is objective without any preconceived vision, it delegates to the respondent the expression of the subjective part of her/his vision.

Adding a point marker is the simplest operation (Figure 1a). On the other hand, it suppose from the user to be precise, which is often not advisable considering the above mentioned respondent point of view: as soon as it is related to privacy, the respondent may hesitate to be precise enough, and we do not want to force the user to "lie" about the location.

Using a circle allows to remain vague with an approximation of the location (Figure 1b). However, the average user is not used to draw circles on a map and we aim for surveys easy to pick up for a wide audience.

The same goes for drawing a polygon area (Figure 1c), it is even worse. User testing has shown how some users are unable to close the polygon. Furthermore, often users waste unnecessary time wondering whether or not a particular building should be included in the area or not, which is rather inefficient.

Scrawling (drawing freehand) an area proved to be intuitive and adapted (Figure 1d). Nonetheless, the problem is then translated at the implementation level, given the aim to produce a web responsive survey and that the desktop with a keyboard and a mouse has nothing in common with the gestures available on mobile.

Also, when respondents have the freedom to draw either points, circles, polygon or scrawled areas, it may be difficult for the analyst to infer trustworthy results from potentially so different answers.

Because of all the drawbacks listed above, the approach described below seems more appropriate and less risky.

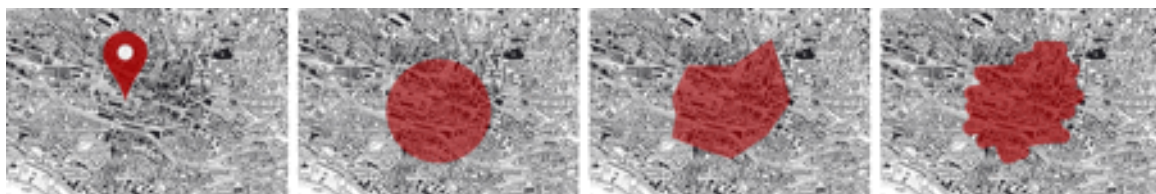


Figure 1: From left to right (a) Point (b) Circle (c) Polygon area (d) Scrawl (freehand).

### 3.2. Input by selection

With this second approach, the answer is a "portion of territory" which is a selection of one or many choices made by the user on the base of pre-existing entities. At a first glance, the expected interaction can indifferently respond to the logics of a single choice (radio- button) or a multiple choice (check-box). In the context of our case studies, the selectable entities are only polygons. Therefore, for questions of type "where do you live?", it will be necessary to define a layer of entities - in our case a regular grid covering the building areas - and to ensure that the scope of the selectable entities represents a good compromise between:

- User: a threshold in term of privacy perceived as acceptable by the user
- Analyst: a precision as sought by the survey designer
- Developer: a reasonable weight of the data to embed in the survey web page

#### 4. From a Page Layout to a Web Framework

Let's consider the following question: we want to know in which area(s) the respondent does practice certain activities. With a survey in paper format and to make the best use of the layout, a list of all the possible answers may be presented just below the map (Figure 2).



Figure 2: Example of a cartographic question for paper format.

This arrangement fits well on paper since the respondent has the question and the related map right in front of her/his eyes. But it is not advisable to transfer this logic as is on the web. Of course, it is possible to simultaneously display side-by-side a map and a list of check-boxes on a standard computer screen, but in terms of user experience it would be much nicer to interact directly with the map to respond. In this way, the numbering used for paper format would no longer have any reason to be. The mental effort could then be concentrated on the question itself rather than on how entities of the map are linked to the check-boxes.

Also, given how small and diverse the screens of smartphones or tablets are, definitely the paper model has to be avoided. We cannot reduce the size of the image without the risk of losing legibility or ask the user to scroll the page all the time to alternate between the map and the check-boxes. Therefore it is important to think differently.

Since we're talking about cartographic issues, a JavaScript cartographic library has to be chosen so as to go beyond the simple static image. The three most well-known libraries are probably Google Maps API, Leaflet and OpenLayers. As a research institute attached to a public university, we tend to favor open source technologies for the advantages they offer both in terms of education and applied research (Ertz et al. 2014). Between OpenLayers and Leaflet, we usually chose the first one (currently in version 3) because it is the framework we know best and it is also with this framework that we offer various courses to our students in geo-information (Geoinformation 2017).

With this library, we can easily produce a map of the size of our choice, centered on the position of our choice and with standard finger gestures already included (zoom, pan). This responsiveness solves the size issue of the map discussed above.

## 5. Geographical Data Best Practices

Any good webmapping library can add vector features on a map. These can be provided in multiple formats, GeoJSON, GML, GPX, etc. We chose the GeoJSON format because it is based on JSON which is lightweight and supported by many JavaScript libraries. Like jQuery, an useful library for addressing non-geographic aspects of a survey.

As soon as the entities are defined by the urban planner or extracted from a GIS (e.g. the regular grid covering the building areas), they have to be encoded with the GeoJSON format. We associate an identifier with each object, usually a unique attribute is enough to serve the three following needs: to meet the requirements of the analyst, to allow the identification on the map, to optimize the weight of the GeoJSON file.

OpenLayers allows to overlay features (e.g. polygons) transmitted through a GeoJSON file and to associate them with a style (Figure 3). The definition of the fill and stroke visual variables should avoid any confusion between the base layer of reference (which also requires the greatest attention) and the overlaid features.

Also some other aspects must be considered when creating GeoJSON files. In Figure 4 the cartographer proposes a relatively tight regular grid cut along the borders of the city of Lausanne. The aesthetic aspect is of a nice effect. But some areas on the edge are so small that they may contain only one building and then the user privacy problem mentioned above is encountered again. In addition, the small size of the areas on the edge forces the user to zoom in to ensure that she/he is ready to designate the right entity. The weight of the file is considerable (more than 500KB), which is not reasonable given the number of questions to provide or given the weight of other files (JavaScript, CSS, HTML and images).

By choosing a wider grid (Figure 5), we assume that the loss of precision results in a gain in efficiency, at least from the point of view of the user. Similarly, by presenting the entities in their raw form (not cut out according to the municipality perimeter), by reducing the number of decimal places on the coordinates of the GeoJSON file, and in some cases by using a topological format (e.g. TopoJSON), we come to an extremely compact file which speed up the loading time. An ultimate refinement would be to eliminate areas that are not relevant for the question (e.g. forest areas when requesting the place of residence) with a double benefit, decreasing the weight of the file and improving the legibility for the user.



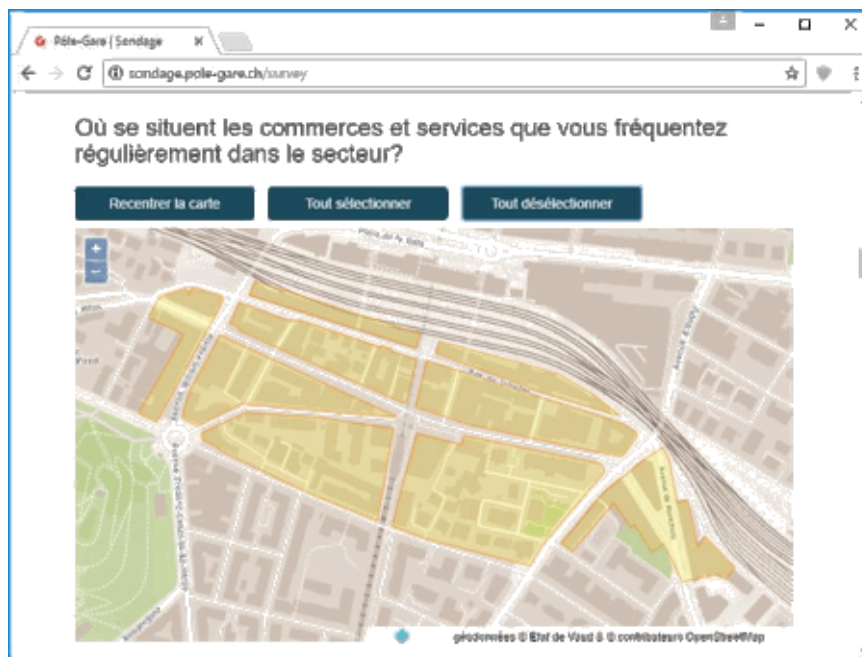


Figure 3: Example of GeoJSON integration with OL3 (customized OSM base layer).

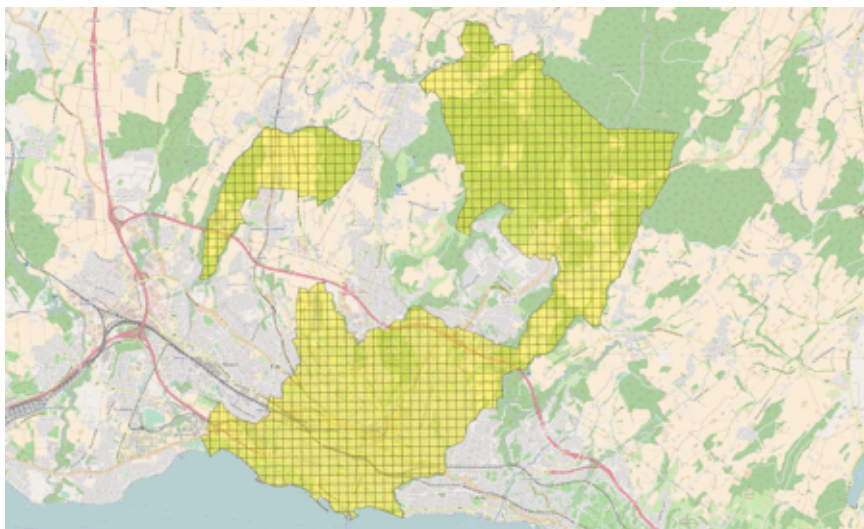


Figure 4: Without applying the guidelines (example of a regular grid covering the municipality of Lausanne).

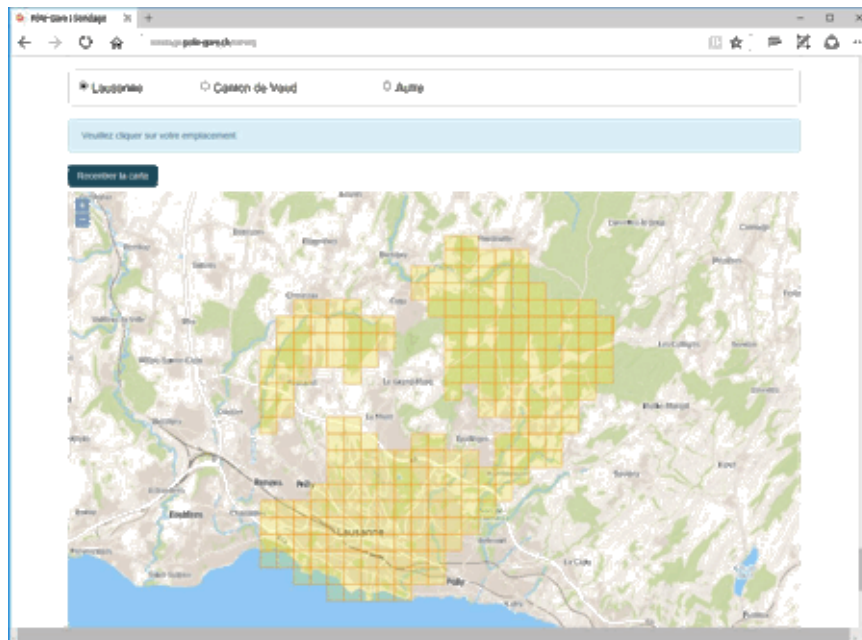


Figure 5: Considering the guidelines (example with all best practices applied to the city of Lausanne).

## 6. From Interaction Design to Implementation

In the previous section, the problem has been simplified to such an extent that it is now only about questions to answer by clicking on square areas on a map. Except the unknown ability of the average user to read a map, the proposed design is certainly efficient from the point of view of the user experience. There is no longer any intermediate step to link the check-boxes with the identified square areas on the map. In the following, details are given on the implementation and how to solve problems which ensue from.

At first, the user has to get a feedback as soon as she/he clicks a feature. This is essential to differentiate the selected features from those that are not. For instance, OpenLayers makes it easy to give a different style to features when they have been selected (Figure 6). Next point is then to find a way to gather the features selected by the respondent so as to be easily sent to the back-office. Our technical approach has been to address this problem in two parts: first, and given that each feature has been created on the map with a unique identifier, it is to retrieve the identifiers of the selected features so as to create HTML check-box elements, each holding one of the identifiers; secondly these elements are configured to be hidden in the user interface but ready to be sent to the back-office when the form is submitted. Regarding the back-office, this represents a quite loosely-coupled approach allowing to use any server-side framework. We have chosen to use Ruby on Rails to process the data and store them with PostgreSQL database system. The source code of both the front-office and the back-office is available online ([MediaComem/survey-Pole-Gare 2017](https://github.com/MediaComem/survey-Pole-Gare)).

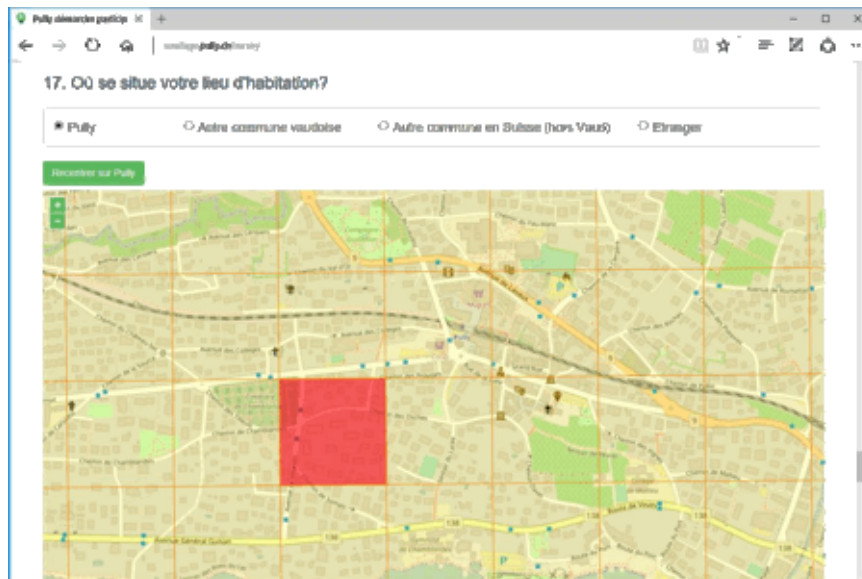


Figure 6: Example of single choice selection for the personal address (city of Pully).

Among the good practices discussed above to produce GeoJSON files, one is to find the right compromise between precision and efficiency, trying to control the number of features to be displayed. It reduces the loading time but also reduces the time needed by the user to answer. However, in the case of multiple choices, it is also necessary to avoid having to click on dozens of elements, which can be time consuming. But if this were to happen, we could further reduce the user effort by offering buttons to select or deselect all features with a single click. With the example presented in Figure 7, there are 20 selectable features from which 13 are selected (in red). Via the "select all" button the user can achieve this operation in 8 clicks instead of 13.

During pre-production phase, user testing has shown that it was quite common to see users quickly scroll the survey to skim through it. By default, on a computer, the more convenient way to zoom on a map and the action of scrolling a page are done in the same way, via the mouse wheel. And on a smartphone or tablet, the action of scrolling a page correspond to a pan on the map. As a consequence, the user may be easily disturbed when the intent is to scroll but has pan or zoom as a result. And what is even more disturbing is to see the zoom level or the initial position of the map involuntarily altered.

To solve this, we may think to disable the default behavior of the map during an action of scrolling the page. However, the problem persists if the action of scrolling does start from the place in the page where the map is presented. It is therefore necessary to calculate the dimensions of the map so that a margin remains on the screen, that is a space used as a starting point of the action of scrolling, especially on the tablet and smartphone. The Google Maps API offers an interesting solution by completely disabling the default action of pan on a map. The desktop user is then forced to use the zoom buttons and the mobile user to move on the map with two fingers instead of one. This solution seems to be the most appropriate, although you should at least be Google to impose a not necessarily natural and common practice to a user community!

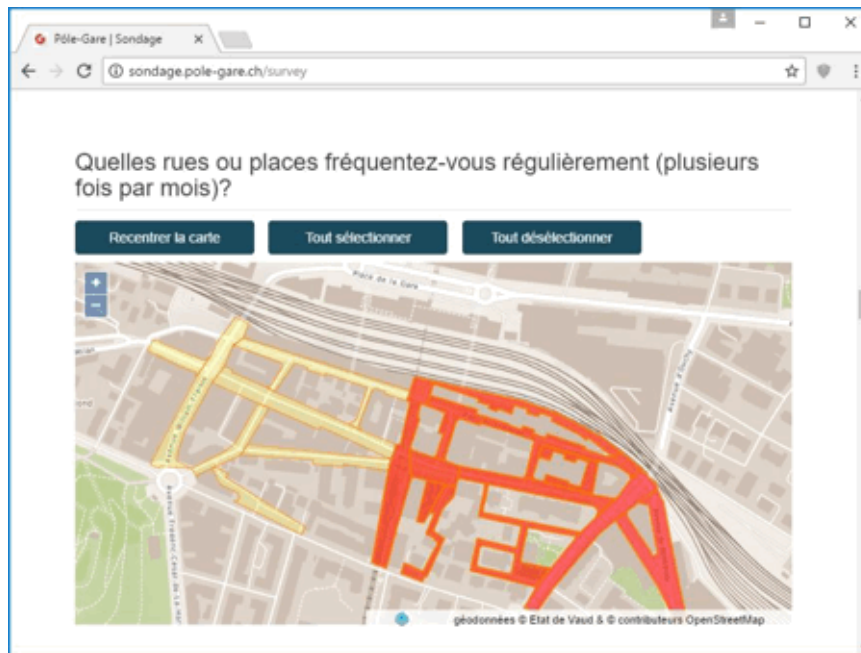


Figure 7: Buttons to help the user for selecting and deselecting features.

Finally, other user testing does show how it is useful to have a map centering button that allows the user to reset the zoom level and the extent of the map when the context is lost when navigating. Also, in order to focus the users' attention, it is advisable to limit the overall extent of the map to the maximum (Figure 8). In this way, it is not possible to move the map too far outside the concerned geographical area (e.g. 10km around the bounding box of a city).

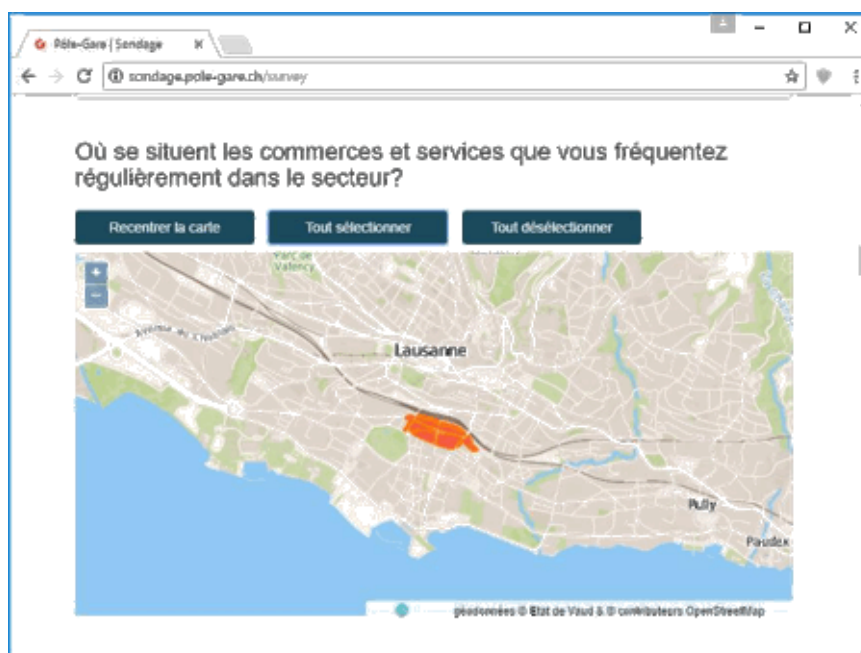


Figure 8: Maximum extent for Lausanne city. Only the red areas are useful for the question.

## 7. Practical Results

To complete the many guidelines for the design of usable web form (Bargas-Avila et al. 2010), we suggest the following recommendations when it is essential to incorporate a cartographic question in an online survey. These are validated empirically by means of the experience gained through the two case studies with the municipalities of Pully and Lausanne.

From general considerations to the specific design of the cartographic input type, the following guidelines are proposed:

- Guideline 1 Consider the data analyst requirements in terms of data precision, usage and analysis
- Guideline 2 Consider the respondent privacy and the time to respond
- Guideline 3 Use a Javascript cartography library to display the map.
- Guideline 4 Build a grid (vector layer) and use input by selection approach to collect answers from the map.
- Guideline 5 Consider the stroke and filling colors of the grid to avoid any confusion between the map and the grid and/or adapt the base map layer.
- Guideline 6 Find the good compromise between precision and efficiency to limit the number of the grid areas as much as possible.
- Guideline 7 Do not create grid areas too small (or choose conscientiously the areas size to fit the respondent and data analyst needs).
- Guideline 8 Limit the coordinates number of decimals and in some cases, it may be relevant to consider the TopoJSON encoding format to compact the vector file.
- Guideline 9 Eliminate the areas that are not relevant for the question (e.g. pieces of lake, forest, etc).
- Guideline 10 Obviously, use different colors to differentiate selected features from those that are not.
- Guideline 11 Use traditional hidden form elements like checkboxes and radio buttons and bind them to the cartographic grid using unique identifiers.
- Guideline 12 Show select all and unselect all areas buttons to help respondent.
- Guideline 13 Show recenter button to help respondent to reset zoom level and extent of the map.
- Guideline 14 Disable the default action of pan on a map and invite the desktop user to control navigation with the zoom buttons and the mobile user to move on the map with two fingers instead of one.

Moreover, the latest survey conducted with such cartographic questions has drawn up a list of 1530 responses, about half of which came from mobile devices. Only 63 responses (4%) remained unanswered for the cartographic questions. From which a little more than the half have been filled from smartphones or tablets. It is hard to say whether these questions remained unanswered is due to understanding problems (difficulties to read the map or to use the selection mechanism) or because the respondent simply did not want to answer. However, it is very likely that for a large part of these unanswered questions are related to the user's browser. Indeed, log analysis shows that 42 surveys in the 63 unanswered come from old browsers (Safari <6, Android <4 or IE <9) which can be problematic with the technologies used. It is therefore highly likely that the cartographic questions did not get displayed at all or at least not correctly in these cases.

## 8. Conclusion

The work carried out around these cartographic questions was successfully able to improve the user experience while preserving a traditional way of processing the results (simple scores are associated with the different geographical entities) for the analyst. It is also to notice that many respondents did communicate their significant satisfaction to be involved in such an participatory initiative. The good quality of the designed web form did probably participate to this positive judgment.

At the same time, some guidelines have been extracted as expected. This is to such an extent that all these good practices of design are now ready to be integrated into a specific library to be created and dedicated to cartographic questions for an interactive survey form. This would be a logical follow-up to the project. As a public funded research institute, the release of such a library would be done following the vision of [Ertz et al. 2014](#). Indeed, they consider source code as text to share just as any research documentation, in other words, open source as a necessary condition to enable reproducibility, a core principle of science.

Also, beside the many guidelines for usable web form design that were applied in this work, it would be desirable to validate all these usability recommendations concerning the cartographic questions by pushing forward user testing, with eye-tracking in particular ([M et al. 2014](#)).

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