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Panel of sensitive mapping experiments with respect to various sources of information

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Abstract: Sensitive mapping corresponds to a process of making maps by consciously integrating personal subjectivity about a space during observation and visualization. The approach is mobilized to express emotions, sentiments and opinions associated to a spatial environment as well as a mean to be attentive to this environment based on the five senses. The objective of the work is to explore the relations between sources of information about a space and resulted maps. Three sensitive mapping experiments implemented during the seminar in sensitive mapping in *École des hautes études en sciences sociales* (EHESS) are described. Different sources are used: direct observation, audio records and texts. The maps made by the participants were analyzed according to the criteria of the chosen material, the conceptualization of space, the scale and extent, the selection and display of information. Specificities and similarities between maps helped formulating hypotheses about the role of map-makers and the apprehension of space depending on the sources. Direct observation implied that the map-maker is physically in a space. Subjectivity can be seen on the maps through little completeness of the landscape features and display of emotions, sentiments and opinions. Audio records and texts implied that the map-makers did not go into the space. Maps contain relative completeness and details of information from the sources, mainly regarding landscape features. Interpretations by map-makers appeared more in the design than in the information selection. Sources of information can thus be considered complementary and sensitive mapping experiments can combine them to gather knowledge and perceptions about a space.

Keywords: sensitive mapping, source of information, experiment, information selection, map analysis

1. Introduction

1.1 From field to map: various sources of information

Maps have taken various forms over time. They have fulfilled different needs and functions (e.g. historical Portolan charts for navigation). They correspond to different contents (e.g. shorelines, ports) and are dependent on the technics and tools (e.g. compass) and on the media and materials (e.g. vellum, printing). Each time, until today's digital technologies, has brought new opportunities and so new ways of exploring the space, collecting information and then displaying and disseminating this information (Arnaud, 2022; Hofmann *et al.*, 2012).

A research issue is about identifying the process from field to map and so to specify the relationship between the space as perceived and as described and an edited display (Zwer *et al.*, 2022; Arnaud, 2020; Gartner, 2012; Dewaele, 2011). Depending on how the field is observed, corresponding maps come out differently (Cardoso *et al.*, 2022). From field to map, there are intermediate processing steps that select, structure, interpret and conceptualize (Béguin *et al.*, 1994). First in the process,

the step of observation and collection of information implies that one or several individuals, not necessarily the map-maker, travel in situ or remotely through a space. Second, information about the space is described using a medium and this description constitutes a source of information on its own. The medium can be memory, a text, a record, drawings, notes, photos or movies. Then the map is drawn.

Analysing relationship between fields and maps may be based on the contents of the maps with respect to the successive steps of the mapping process. Existing approaches to analyze a corpus of maps depend on the characteristics of the maps including the material and the thematic. For maps in paper format, such as historical maps and contemporary drawn maps, a challenge is to be able to read information and to take it into account for qualitative interpretation or quantitative analyses. Information can be digitized and categorized into databases, then geolocalized. Considering map content can be done systematically by scanning and describing every map elements. List of landscape elements can be established, such as in the study of historical city maps by Dupont (2020) and in the study of the Cassini map by Dumenieu *et al.* (2019). Symbolization (graphics, colors)

can be described. In Xie (2019), detailing semiology enables to focus on important buildings and to witness urban evolution in old maps of London. In Kent *et al.* (2009), designs of European topographical maps are characterized and classified based on several criteria such as the hierarchy of mapped features, the symbols, the lettering and the scale. Locations of displayed features can be compared between maps and between maps and fields e.g. using regular grids such as in the analysis of drawn maps about perceived risk of mudslides in Heitz *et al.* (2018) and in the comparison of frontiers of Europe drawn according personal opinions in Didelon *et al.* (2011). To complete the means of systematic reading and analysis that are intended to be objective, user tests can be implemented to describe maps. Hagemeyer-Klose *et al.* (2009) evaluated efficiency of different existing flood hazard maps. Harrie *et al.* (2015) defined readability measures and qualified, based on user tests, maps classified by their scale, their level of detail and their symbols.

1.2 From field to map: subjectivity in cartography, conventional and sensitive

In cartography, the goal is to display a part of land in a reduced plane or relief format. There are numbers of possibilities to observe the space to be mapped, and to map it. Perception of the space has changed over time and besides technical developments, maps translate these changes (Dupont, 2020). One way to see the process of cartography is that a unique field may correspond to as many maps as there are map-makers. Differences between maps come from the field observation and from the specifications in content and in design of the maps as these aspects are under the influence of individual subjectivity. During the field observation, each person experiences the space according to previous experiments, to cerebral parameters such as emotions, sentiments, opinions, imagination and to physical parameters that are the five senses (Tuan, 1975; Wright, 1947). Concerns about subjectivity in the map-making process are due to the use and usability of the final map. In conventional cartography, rules and theories were developed to optimize objectivity in the map display, which consequently reduce the gap between the message shaped by the map-maker(s) and the message read by map user(s). Earth models, projections and scaling rules offer mathematical frameworks to downscale the field (Béguin *et al.*, 1994; Brunet *et al.*, 1992). Semiology rules enable to associate graphic symbols to pieces of information. Visual variables have been formalized to display information structured regarding qualitative differences, orders or quantities (Robinson *et al.*, 1995; Bertin, 1973). Readability capacities are taken into account, for instance the maximum number of distinct symbols in a key so that the map can be read. The final maps are assessed regarding readability, legibility and interpretation, e.g. implementing user tests which also integrate subjectivity (Fabrikant *et al.*, 2012 studied how map contents are interpreted; Coltekin *et al.*, 2009 used eye-tracking techniques to analyze how maps are physically browsed).

In conventional or non-conventional cartography, when a map is intended to be used by other users than the map-maker, questions arise on the gap between the cartographic message as shaped by the map-maker and the message as read by a map user.

Conventional cartography aims at limiting subjectivity, whereas other approaches in cartography highlights this subjectivity. However, dichotomy between approaches with respect to subjectivity, or objectivity, is not strict (Harley, 1989). A gradient in the consideration of subjectivity exists among map-making approaches. The gradient spans from limiting and framing subjectivity to making it visible and explicit. In this article, we focus on the sensitive mapping which is an approach integrating explicit subjectivity. Sensitive cartography is close to other approaches, non-exhaustively: cognitive mapping, mental mapping and perceptive mapping. Each vocabulary corresponds to a rich literature and their definitions can overlap (Olmedo *et al.*, 2022; Gould *et al.*, 1984; Lynch, 1969). Sensitive cartography aims at displaying a spatial environment through subjectivity that can be of one individual or a group of people (Pichon, 2015; Bailly, 1991). Contents of the maps focus on how environmental features are perceived. Graphic display is about creating a down-scaled part of land as perceived. This display can benefit from evocative media and materials in order to help conveying information about perception.

1.3 Objective of comparing different sources of information in sensitive mapping experiments

Defining relevant experiments in sensitive mapping with adapted protocols, i.e. guidelines, is crucial to obtain targeted knowledge and increase the potentialities of created maps with respect of a part of space. Sensitive mapping stands as a method that can produce knowledge about a space as it focus on perception and on environmental features that may be rarely displayed. In this problematic, we are interested in the relationships between the observed field and the corresponding maps.

Our general objective is to explore the relations between sources of information and the way information is mapped. The research hypothesis is that differences between sources of information that are part of the protocol (direct observation, audio and text in our study), imply differences between mapped information. Differences may concern the selection and the symbolization of sensitive and topographic information. There are numbers of parameters that influence a final map display, which are difficult to isolate from each other. Parameters may correspond to the context of the successive processing steps (perceiving, describing, and mapping) and to individual choices (knowledge, taste). Though, we assumed that differences due to sources of information still remain within the final displays of the maps because the source of information is a key aspect in the mapping process.

We will present the corpus and our method to analyze this corpus, then we will synthetize the analysis results, at

last we will discuss the potentialities of sensitive mapping experiments to better understand a space.

2. Map corpus and method

2.1 Map corpus

The studied corpus contains maps that were created during the teaching and research seminar *Atelier de cartographie sensible*. This seminar is held every year starting from 2016 in *École des hautes études en sciences sociales* (EHESS) in Paris, France (<http://psig.humanum.fr/cartes-sensibles/>). During the courses, sensitive mapping experiments are proposed to participants. The participants come from training programs and research laboratories mainly in sociology and in anthropology, psychology and geography. Protocols defined for the experiments are the set of instructions leading to maps. Three protocols (Table 1) have been selected in order to study potential differences in the maps due to the sources of information which are:

- In situ observation of the space. Observation is made by participants while walking. Filters of observation are used, for instance noise, building use, nature. The mapping was done on the moment of the walk (mainly note taking) and by memory while going back inside;
- Audio records of bicycle itineraries with spoken comments of the rider and sounds from the environment;
- Extract of written texts from novels. Texts are literacy classics with descriptions of a given site or along an itinerary, e.g. *L'assommoir* by Émile Zola and *Une Traversée de Paris* by Éric Hazan.

Protocol	Mapping observation of space	Mapping bicycle audio record	Mapping text
Document corresponding to information source	In situ observation with a filter	Audio record	Extract of texts from novels
Number of sources	Along as many itineraries as participants	2	8
Characteristics of the sources	Whole Paris or itineraries of around 2 km	Itineraries of 4 km, 15 minutes per record	300 words in average per extract
Time length of the experiment	4 hours	4 hours	2 hours
Date of implementation	2018 and 2019	2018 and 2019	2018
Number of participants	23	24	58
Number of maps	26	31	70

Table 1. Three sensitive mapping experiments: description of the protocols including the different sources of information from which the maps were created.

Protocols provided two main types of sources. The first type was direct observations of the space by the map-maker. The second one was given by intermediate media,

here audio records and texts. In the case of direct observation, spatial and sensitive information are collected and formatted by the map-maker. In the case of intermediate media, there is an additional formalization between the spatial environment and the map that is not set by the map-maker. Created maps thus correspond to a spatial environment which is perceived and lived by the map-maker, or which is first described as perceived and lived by an external author and then this description is interpreted and displayed by a map-maker. In all protocols, the spatial area is Paris, as a whole city including close suburbs, with focus on neighbourhoods. Mapping was done during the courses by group sessions. The maps were created after observation, partly based on note-taking and on memory. Instructions and explanations were given to all map-makers. The 105 map-makers were in great majority students, a few more women than men. The main media was paper and the material was free to choose e.g. drawing techniques, fabrics, stickers. Individual and collective maps were created, increasing the number of maps relative to the number of participants. In total, there are 127 maps from the three protocols, evenly distributed among the audio records and the in situ observation, and around a double more for the texts.

2.2 Method

The method to identify the relationship between protocols, especially information sources, and the resulted maps is to analyze the maps and the associated mapping processes which have led to the resulted maps. This is a bottom-up analysis in order to identify potential influence of sources on how environment is mapped. Thus the specificities encountered in maps of each protocol were looked at. We focus on what is specific to the sensitive mapping approach regarding selection of information: perceptive information (five senses), information related to the expression of subjectivity (emotions, sentiments and opinions) and also information as selected from field to display, and regarding geometrical display and symbolization: whether conventional or unconventional.

The analysis of each map of the corpus is based on a list of criteria inspired by the generic steps in cartographical processes and corresponding to descriptors of a cartographical process and of the map content (Dominguès *et al.*, 2009). Criteria are defined as follows.

- Drawing of the map: medium (e.g. paper), materials (e.g. ink, fabrics), drawing of specific elements on the map such as title, key, frame, etc.
- Conceptualization of the space: collection of information and its modelling. Collection can be by memory or by taking text notes and sketches. It may rely on external sources like existing maps or photos. Conceptualization of the spatial environment is interpreted based on the design, e.g. schematic shapes, different levels of detail between elements. It may reflect individual perception of the structure and the use of space.

- Spatial scale and extent: the interest is how reduction of space is implemented. Scaling rules are commonly used though in sensible maps, distances and shapes can be distorted and observed topological relations can be personal.
- Selection of mapped information: specific elements in the map. It can be landmarks of landscape features and in sensible maps it can be perceptive information, emotions, opinions and individual hierarchy in the displayed elements.
- Symbolization: it is the symbols defined for displaying elements such as semiology variables, place names, written words.

The implementation of the analysis consisted in scanning paper maps. Each map was numerically identified and annotated following the defined criteria. Annotations could be associated to the whole map or to specific located elements. Description of maps from different sources of information were synthesized and compared.

3. Analysis of resulted maps depending on information sources

In this section, analysis of the created maps is presented according to the three sensitive mapping protocols. It is structured according to the defined criteria in 2.2.

3.1 Mapping from field observation

In the protocol of field observation, the map-maker is the one who observes the spatial environment and displays it as perceived. Given instructions were to be attentive to space through one filter free of choice. Chosen filters were shops, metal plates, sky opening, vegetation and animals and more generally nature, density of people, sounds. An additional collective map was created by all participants of a same session in order to gather individual observations (extract in Figure 1).

All final maps were drawn on paper, based on memory and written notes taken on the field mostly about the chosen filter. White paper sheets were provided as well as a whole set of black and colour pens, scotch tape, staples, stamps, fabrics, stickers. To locate information, map-makers either used existing background maps (30% of the 26 maps) or white paper displaying a line corresponding to the followed itinerary (70%). Mapped information was displayed by symbols and text (key being written aside 25% of the maps).

Conceptualization of the space corresponded to a spatial organization of two types, global (55%) or built step by step (45%). Space was drawn along the travel itinerary which was one central single route line with information on each side of the street or which was two lines corresponding to the borders (buildings, sidewalk). Some maps (n=2) were displayed in angle of view in perspective that could correspond to a global and distant personal insight of the mapped space. The shape of the route line was either similar to the itinerary (street turns and straight parts), or it could diverge (use of other landmark like street name for deviation instead of turns).

The extent of the maps could be adapted to one sheet of paper or extended progressively with new sheets of paper (25% of the maps). Maps are mainly high-scaled at the level of detail of the streets.

For the selection of mapped information, feedbacks of the participants were that it was difficult to select and synthesize information directly on the field and that memory in the selection is also crucial, focusing on salient observed information. The observation and interpretation of the space are dependent of personal knowledge. For instance regarding the filter about nature, knowledge about the history and configuration of the green spaces in the city of Paris has mattered in the selection of information. Participants were asked beforehand to name elements of nature. Answers were public green spaces (gardens, squares), trees and vegetation, evidences of animal presence (e.g. birds' nest and singing), absence of traffic sounds. More ambiguous elements are quoted such as human facilities for wildlife: insect houses, beehives that have been installed on rooftops. After field observation, green spaces have been consensually displayed. Some elements were added such as hydrography, e.g. the Seine River. Other elements were noticed but not displayed on maps due to scale and scarceness such as plants in the pavement interstices. In all maps, salient information is mainly about the filter, though landmarks have been displayed that can be used for relative location such as roads and specific buildings.

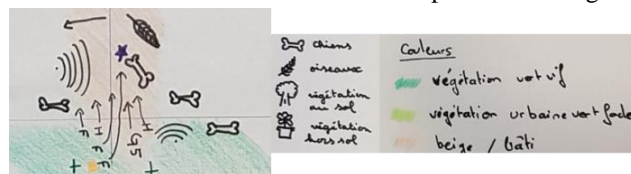


Figure 1. Extract from a collective map displaying individual observation filters: mix between conventional and personal symbolization. Vegetation display uses conventional green colors; observed animals are displayed using figurative symbols (bone, feather).

Conventional symbolization including rules about visual variables was mobilized, mainly for features commonly displayed in topographical maps: vegetation (in green colour), roads (in black) and hydrography (in blue) (Figure 1). Concerning sensitive and perceptive information, some figurative symbols were used, e.g. traffic sign for cars, ear for sounds, or evocative symbols e.g. hatches for sounds. Colours were chosen to highlight personal positive or negative assessment on features or to highlight well-known features.

3.2 Mapping audio records

The second protocol is based on audio records during a bike ride. Map-makers were asked to display the travelled space as being described by the rider and speaker. The records stand as third-party sources for the map-makers.

For the drawing of the maps, white paper sheets and the same materials as for the protocol of field observation were provided. Most formats of the final proposed map were adapted to the linearity of the movement of the rider describing and perceiving the spatial environment. No

existing background map with streets layout and names was supplied, though some map-makers printed one in order to support the location of mapped elements and especially of sensitive and perceptive information. Those background maps were integrated into the final map or only used as an external resource so that to visualize the spatial environment and to help locate the spatial features. All map-makers produced intermediate materials: note-taking or sketch maps. As for the protocol based on texts, map-makers had full access to the source, meaning that they could listen several times the records, press pause or browse.

The conceptualization of space is related to the layout of the cycling itinerary explicitly displayed by a line or not. In the same way that in the audio, the space is described from one place to another successive place, the produced maps contains elements that were located and designed related to each other successively, e.g. a store located near a crossroad on the map, as both elements are mentioned successively in the record.

Among the produced maps, the spatial extent was defined according to the itinerary. One approach by the map-makers was that the layout of the route was defined in advance within a format (one or several sheets of paper). Another approach was to adapt the format as the drawing proceeds (by assembling the sheets). Maps were of high spatial scales, due to the relatively low movement speed of a bicycle within the city streets and to the precise description of the space that could be given by the rider. Though, levels of details differ according to record segments: when the rider is describing a temporary event (e.g. someone is crossing the road), the description of physical spatial environment is let aside. Contrary to a written text, there is no overlay of formulated information at the same place and time in the live audio records.

The selection of information was explicitly made by the map-maker. During note-taking or sketch map while listening to the records, there were a selection as not all information given could be listed. Some map-makers listened to the audio record in a raw, taking the most exhaustive notes as possible, and then made a selection afterwards. Other map-makers navigated through the record and organized their notes progressively while stopping the record. Maps contain: the layout of the itinerary, the road network displayed explicitly or implicitly by buildings or elements on both sides of the roads, elements of the environment perceived and described by the rider e.g. public works, salient architecture features and the sounds captured by the recorder e.g. car traffic, horns. In the final displays of the maps, there is a will to describe the space as used by a bicycle rider, in particular relevant elements for cycling such as bike paths, traffic signs, temporary public works and other users in the streets such as pedestrians. The selection of some items has induced the selection of other items, e.g. the selection of mentioned pedestrians has induced the selection of mentioned pedestrian crossing. No drawing of the rider was done, only the rider's comments and the surrounded sounds.

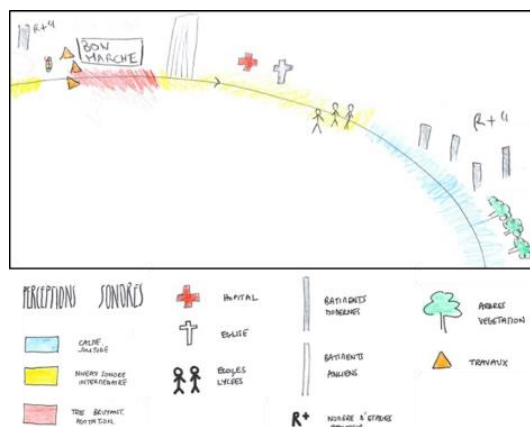


Figure 2. Formulated information (buildings, trees) and background sounds from the audio records (displayed with three colors corresponded to calm, intermediate and noisy).

Symbolization related to the displayed elements corresponds mostly to punctual symbols for specific features, e.g. buildings (estimated date of construction, style, colour, height) and urban furnishing, and to a line for the road textured depending on the covering (Figure 2). Elements were either displayed in perspective or by flat polygons. The background sounds in the audio (other than the rider's voice) contributed to the general atmosphere perceived by the map-maker though were said to be quite difficult to display: voice from other people, cars, noise from public works. Some unusual materials for maps were used to convey information and to help the display of unusual mapped elements, e.g. metal staples for barriers. For most maps, a key was displayed. When no key were provided, symbolization was mostly designed as evocative, e.g. a more or less high sinusoid for the varying intensity of noise.

3.3 Mapping texts

In the third protocol, information sources are texts from novels corresponding to descriptions of existing places as observed, interpreted and imagined by the writer. The map-makers were asked to display the spatial environment as described in the texts, taking into account physical elements as well as described perception (senses, emotions, sentiments, opinions). As well as for the audio records, these texts are a third party point of view of a perceived space for the map-maker.

Created maps were drawn on sheets of paper that were supplied, containing the text and a white space for mapping, and with a set of black and colour pens. Some explicit links (drawn arrows) have been made between segments of text and the parts of the maps. Drafts were sometimes produced before a final version.

Several displays mix 2D and 3D displays. Some maps correspond to perspective views, e.g. buildings and roads from an elevated angle of view and perspective line. Some maps contain a displayed line explicating the limit between the ground (and the elements shortly above) and the sky. 3D displays of buildings and landscape features (roads, bridges) are present in half of the produced maps (Figure 3). Other landscape elements are not that obvious

to be displayed in 3D and 2D was used partly due to drawing limitation. The space travelled along an itinerary is displayed thanks to a line or to successive arrows. In the narration of the different texts, disorientation or interrogation about the location of places are described though have not been displayed in the maps.



Figure 3. Figurative symbols and drawings: display in 3D of buildings and of a bridge.

Multi-scaling is found within several maps. Scaling variations are related to the different levels of details described in a same text and to the importance given to the described elements by the map-makers.

Selection of mapped information corresponds to spatial landmarks, e.g. the layouts of the streets. Most produced maps contain a topographic background including topographical elements: roads, buildings, vegetation, water features. Aside from the topographic background, selection of information is different between map-makers. Shared pieces of information can be encountered among the maps, especially if highlighted in the text. Highlights can be about unusual elements (e.g. spotted colour lights) and elements described or mentioned several times (a balcony). Extracts from the novels contain rare phenomenon, that are displayed or not depending on the map-maker, for instance cars that rarely pass by a street or a place with a few stores. In general, absence is not displayed or can be displayed by a proxy, e.g. when it is written that few people risk walking in a street, one map displays a succession of inhospitable buildings.

Symbolization mainly correspond to figurative drawings and so the visual variables shape, texture and intensity. A key is present in most maps. In a few maps with no key, some symbolization choices, e.g. colour codes, are difficult to interpret and left to interpretation of the map readers. Words are largely used in order to display information such as place names, landscape elements types, and mentioned absence in the text and so not symbolized but written, e.g. the words “no dogs barking” is taken from the novel and placed in the map.

4. Discussion: differences and shared map characteristics regarding information sources

Analysis of maps created from the three sensitive mapping protocols highlights some differences as well as common characteristics, regarding the selection and display of the spatial environment as perceived.

4.1 Information selection

The list of criteria for analysing the maps was not an evaluation grid as in sensible maps, there is no correct or

incorrect designs concerning readability and good understanding by a map user. Those criteria remain entries to describe the maps and to structure comparison according to protocols with various information sources. In the implemented sensitive mapping experiments, several interpretation layers stand between the field and the analysis of the resulted maps: the interpretation of the collector of the sources of information (in the case of the audio records and the text), the interpretation of the map-maker when making the maps and the interpretation of the map reader and analyst. The defined protocols were the same for all participants, however there are always degrees of freedom in the implementation. Individual interpretation of instructions comes into play in addition to individual interpretation of sources, knowledge in cartography and abilities to drawing. In the sensitive mapping approach, information may not have been displayed in such a way as to be easily read and understood. Though, all maps have somehow the capacity to store and to pass on an observed reality or a message. Besides, discussions between map-makers regarding their cartographical choices were held after the experiments.

Analysis of the maps enabled to highlight specificities of the protocols and shared features. During the part of information selection from the different sources, there were a balance between live selection and selection based on memory. Taking notes was possible during the handling of the source information in the three experiments. These notes are intermediate productions helping the map-maker appropriating the given information by listing observed, heard and formulated elements and by organizing them. Participants expressed the difficulty to synthesize their observations directly and to display them while on the field, while listening or while reading. In the protocol in situ, chosen filters induced explicit selection while observing in the field and taking some notes and memory acted as an additional filter back inside where the maps were created. Based on notes and memory, mainly salient information was selected. The distance between the observed space (outside) and the space where the maps were created (room inside) may change the selection of information, compared as if the maps had been created entirely on the field. The appropriation of the space was generally strong as observation involved the whole body including the five senses. Subjective comments were integrated to the maps. In the protocols based on audio records and texts, map-makers were not the observers of the space. Access to the sources and map creation were proceeded inside with possible replays and several readings. Memory was less mobilized and the information given in the records and texts was more exhaustively selected. In that sense, map-makers have taken on the role of preserving the perceived space as formulated by the bike rider and by the writer by keeping many details. This understanding should be completed by other experiments and in particular in the light of map-makers' profiles and familiarity in the mapped area.

4.2 Information display

In the map displays, scaling factor between field and map varies, possibly within a same map. Cases that are encountered are: 1. a general score of the space (e.g. road network, limits of the mentioned space in the text) filled with located features, 2. one or several zoom centred on parts of space and detailed with landscape features (e.g. buildings) or aspect of the living space (e.g. people), 3. non-precisely located information and so displayed elements distributed in the map according to existing spatial relations or not. The extent of some displayed elements can be constrained by the format of the given sheet of paper in the protocol.

The information content is relatively complete and detailed compared to the sources in the protocols based on audio records and texts. It is made of landmarks such as buildings, roads and trees, of services such as store brands, of people. The lack and the absence are rarely displayed, except in the protocol based on texts where absence of some facts or elements is written. For all the three protocols, temporary information, e.g. people walking in the street, weather conditions, are more likely to be displayed as the maps are about a spatial environment at a certain date. Not only permanent elements are noticed but also ephemeral ones that correspond to a certain atmosphere that may change at another time. Movement is a central part of the three sources: map-makers walk, listen to a biker that rides, read texts describing different parts of a space or following an itinerary. Movement is not obvious to display on paper maps, though symbols of walking person and moving bicycle were displayed and the layout of the route or an itinerary were associated with arrows. It can be noticed that little information about emotions, sentiments and opinions were displayed.

Symbolization and graphical display mix personal and unusual choices with conventional and common ones. Personal symbols can be used for describing information that is generally not on topographical maps, e.g. density of people, weather. Perception information from senses is displayed with personal symbols inspired by abstract symbols like points or hatches, or by figurative symbols. A number of words are written on the maps, sometimes for place names as in conventional maps, though mainly for perceptive information about emotions, sentiments and opinions. That last type of information is not obvious to associate to a symbol, as no conventions are defined and creating evocative symbols are not easy. The use of conventional symbols has been made for information generally present on maps, e.g. the symbol of a red cross for a hospital, the uppercase letter M for the subway in Paris. In the protocols based on audio records and texts, formulated words can be interpreted to display some information, e.g. when a round lake is mentioned, symbolization will correspond. When the non-travelled space is mentioned, there can be explicit symbols like a crossed out line or place.

Unusual materials (fabrics, stickers, wires) helped displaying a spatial environment in a tangible way and

conveying an atmosphere, which is said among map-makers as difficult to display apart from context elements (e.g. landscape features, works in the streets) and specific elements (e.g. sounds, smells). In the audio records and texts protocols, interpretations by map-makers can be seen more on the display of information, for instance creative, original and figurative, than on its selection which is quite complete.

Keys have been associated to the some map displays. They were decided before or after the drawing of the map. Defining a key before drawing was associated to explicit modelling of the information along the different steps of the cartographical process: browsing through the field, record or text, taking notes, selecting and organizing pieces of information within the notes, defining symbolization for each pieces of information. Defining a key after drawing corresponded to an on-the-fly process and designing the map was intertwined with the drawing. Producing a key is also a way to communicate with the reader of the map, a will to guide the interpretation of the map as close as possible to the intentions of the map-maker.

5. Conclusion

Sensitive cartography focuses and emphasizes the subjectivity of map-makers and of users of a spatial environment. Map-makers are likely to map space as they perceive it, for instance so that to question their own perception of space. They are also likely to map the space based on the experiences of others. Based on implemented protocols during the seminar *Atelier de cartographie sensible*, insights about interactions between sources of information and resulted maps concerned the role in which the cartographers put themselves. When map-makers draw their own observations, mapping is oriented as an introspective work. When they draw observations that were formulated by others, mapping is more focused on reporting and communicating. Completeness of formulated information in the sources audio records and written texts that were displayed in the maps was high. Sensitive information (from the five senses, emotions, sentiments, opinions) comparatively to landscape features was more displayed in the maps from direct observation than in the maps based on audio and text. Description of sensitive information and description of landscape feature, their physical aspects and their configuration both contribute to personal interpretation of a spatial environment and to its uses. Adapting experiments and associated protocols for sensitive mapping are interested to explore potentialities regarding collecting knowledge about parts of space and designing land planning projects. Various possible sources of information can supply the maps and can be used separately or combined.

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7. References

- Arnaud, A. (2020) Cartes et cartographie des ressentis et représentations d'individus : état des lieux, questions sémantiques et méthodologiques. Mappemonde, doi:<https://doi.org/10.4000/mappemonde.4666>
- Arnaud, J.-L. (2022) *La carte de France. Histoire et techniques*. Marseille, Parenthèses éditions, collection Arts, 448 p.
- Bailly, A. (1991) *Les concepts de la géographie humaine*. 1ère édition en 1984, Paris, Masson.
- Béguin M. and Pumain D. (1994) La représentation des données géographiques. Statistiques et cartographie. Malakoff, Armand Colin.
- Bertin, J. (1973). *Sémiologie graphique. Les diagrammes, les réseaux, les cartes*. 1st edition in 1967, La Haye, Mouton & Gauthier-Villars.
- Brunet R., Ferras F. and Thery H. (1992) Les Mots de la géographie, dictionnaire critique, coll. Dynamiques du territoire. Montpellier–Paris, Reclus–La Documentation Française.
- Carvalho Cardoso, J.M. and Ferreira Cavadas da Costa, R.C. (2022) Mapsapes: Applying Anachronic Techniques in Contemporary Maps as a Design Strategy for New Ways of Seeing, *The Cartographic Journal*, Volume 59(2).
- Coltekin, A., Heil, B., Garlandini, S. and Fabrikant S.I. (2009) Cartography and Geographic Information Science, Volume 36(1).
- Dernat, S., Bronner, A.-C., Depeau, S., Dias, P., Lardon, S., et al. (2018). Représentations sociocognitives de l'espace géographique. *Cartotête, 2^{ème} Journée d'études Représentations sociocognitives de l'espace géographique*, 10-11 April 2017, Strasbourg, France.
- Dewaele, A. (2011) Dessine-moi ta ville aujourd'hui et demain... Représentations et imaginaires urbains des jeunes citadins de Chandigarh. *Carnets de géographes*, doi:[10.4000/cdg.2334](https://doi.org/10.4000/cdg.2334)
- Didelon, C., de Ruffray, S., Boquet, M. and Lambert, N. (2011) Un monde d'interstices. Apport de la logique floue pour l'analyse des cartes interprétatives. *Revue du Comité Français de Cartographie*, 209.
- Dominguès, C., Christophe, S. and Jolivet, L. (2009) Connaissances opérationnelles pour la conception automatique de légendes de cartes. Journées Francophones d'Ingénierie des Connaissances IC'09, Hammamet, Tunisie.
- Dumenieu, B., Chadeyron, J., Cristofoli, P., Perret, J., et al. (2019) Engraved footprints from the past. Retrieving cartographic geohistorical data from the Cassini Carte de France, 1750-1789. International Cartographic Conference 2019, 15-20th July 2019, Tokyo, Japan.
- Dupont, C. (2020) Du texte à l'image. Les plans de Jacques de Deventer, un exemple d'appropriation cartographique de l'espace ? Penser les savoirs géographiques à l'époque moderne (XVe-XIXe siècle), n°17-18 novembre 2020-mai 2021.
- Fabrikant, S.I., Christophe, S., Papastefanou, G. and Lanini-Maggi, S. (2012). Emotional response to map design aesthetics. In GIScience 2012, Columbus, Ohio, 18-21 September 2012.
- Gartner, G. (2012) Emotional response to space as an additional concept in cartography. XXII ISPRS Congress, 25 August-01 September 2012, Melbourne, Australia
- Gould, P. and White R. (1984). *Cartes Mentales*. Éditions Universitaires de Fribourg, Suisse.
- Hagemeier-Klose, M. and Wagner, K. (2009) Evaluation of flood hazard maps in print and web mapping services as information tools in flood risk communication. *Nat. Hazards Earth Syst. Sci.*, 9.
- Harley, J.B. (1989) Deconstructing the map. *Cartographica*, Volume 26(2)
- Harrie, L., Stigmar, H. and Djordjevic M. (2015) Analytical Estimation of Map Readability. *ISPRS Int. J. Geo-Inf.*, 4.
- Heitz, C., Marc-Zwecker, S., Mathis, R. and Le Ber, F. (2018). Étude exploratoire des représentations de coulées d'eau boueuse en Alsace : Analyse d'enquêtes psychosociales et de dessins à main levée via un logiciel dédié. *Actes du colloque SAGEO*, November 6-9, 2018, Montpellier, France.
- Hofmann, C., Richard H. and Vagnon E. (dir.) (2012) L'âge d'or des cartes marines. Quand l'Europe découvrait le monde. BNF éditions.
- Kent, A. and Vujakovic P. (2009) Stylistic Diversity in European State 1:50 000 Topographic Maps. *The Cartographic Journal*, Volume 46(3).
- Lynch, K. (1969). *L'image de la cité*, Paris, Dunod.
- Olmedo, É and Caquard, S. (2022) Mapping the Skin and the Guts of Stories – A Dialogue between Geolocated and Dislocated Cartographies. *Cartographica*, Volume 57(2).
- Pichon, M. (2015). Espace vécu, perceptions, cartes mentales : l'émergence d'un intérêt pour les représentations symboliques dans la géographie française (1966-1985). *Bulletin de l'association de géographes français*, Volume 92(1).
- Robinson, A.H., Morrison, J.L, Muehrcke P.C., Kimerling, A.J., Guptill, S.C. (1995) *Elements of cartography*. 6th edition. John Wiley & Sons.
- Tuan, Y.-F. (1975) Place: An Experiential Perspective. *Geographical Review*, Volume 65(2).
- Wright, J. K. (1947) "Terrae Incognitae": The Place of the Imagination in Geography. *Annals of Association of American Geographers*, Volume 37.
- Xie, C. (2019) Procedural Knowledge of Graphic Design for Analysing Graphic Elements in Historical Urban Maps. International Cartographic Conference 2019, 15-20th July 2019, Tokyo, Japan.
- Zwer, N. and Rekecewicz, P. (2022) *Cartographie radicale*. Explorations. Éditions La Découverte, 2096 p.