

**PUBLIC-ORIENTED, MAP-BASED COMMUNICATIONS IN VARIOUS SCIENTIFIC AREAS,
PARTICULARLY WATER RELATED THEMES**

TURCZI V., QUODVERTE P., GRIVEL S.
University of Orléans, ORLÉANS, FRANCE

BACKGROUND AND OBJECTIVES

Map-based communications have a very important role to play at the present time; they are almost the only tools available for publishing and translating spatial data in a graphical system to interested parties in various public spheres. A map is a good tool for visualising data, and it plays a supporting role in decision making (Quodverte, 2005) and in the understanding of water-related problems. Nevertheless, maps do not always meet the requirements of different types of users, and they may not be satisfactory for undertaking the relevant spatial analyses. Often the message does not come through correctly because the cartographic rules and visual variables are improperly used, and the exigencies of the targeted, specific public spheres are not considered when the map is being created.

With the appearance of the digital environment in the science of cartography new visual and non-visual variables are now able to represent different parameters and issues, including the 3rd dimension, movement, time, interactivity, zoom, sound and various others (Cauvin C., 2008). These new cartographic opportunities have opened new channels for communication between the map producer and the map-reader. Meanwhile, GIS software has appeared on the market, opening up a wide new approach to map presentation. GIS applications were automated and accelerated thematic map production, while visualisation was given second priority. Cartographical representation was placed at a disadvantage in relation to data management leading to degradation in quality.

How does communication work in scientific areas? How does cartographic communication look in the present day? With the appearance of GIS, are there new types of classification in thematic maps? Is there a place for cartographical innovation in science?

ACTUAL SITUATION BASED AN A WATER-RELATED EXAMPLE

We analysed water-related maps, which have a high relevance these days. The ecological threat of the red toxic sludge in Hungary can be mentioned as the most immediate example. Water plays a triple role in nature: it has an essential value as a natural resource but on the other hand it can also be a source of power as well as hazard. Water-related problems called for the creation of the Water Framework Directive (EC, 2000), which required the achievement of good underground and surface water quality standards in the EU by 2015, and the Flood Directive (EC, 2007), which had the primary purpose of providing a framework for the EU on flood-hazard assessment and management. These directives require co-operation between countries, and they also encompass mapping obligations for the European Commission. One of the innovative ideas of these water-related directives is public participation (EC, 2000) in their implementation, so the maps produced in the frame of these directives are aimed at three sectors of the public with different demands: decision-makers, experts, and the general public.

The Flood Directive is a relatively young directive so no official maps have yet been published. However, the first Water Framework Directive maps were completed in 2009 (EC, 2009), which means a large number of maps was prepared along several themes. We took two test areas: Hungary and the Loire-Bretagne basin of France. In the first analyses, for every theme just one map model was done, which means that not all the three targeted public sectors were considered. Typically these maps were aimed at the experts, so they were the only public able to interpret the various elements in the maps. Almost 100% of these maps were analytical maps, so they treat only one theme, and a very simple system of variables.

Our findings suggest that map-based communication is currently being used incorrectly, in simply providing illustrative material instead of being used as a means of supporting decisions. Maps do not meet the requirements of the users, and users are unable to find the answers they seek in the maps.

METHODS OF CARTOGRAPHICAL COMMUNICATION

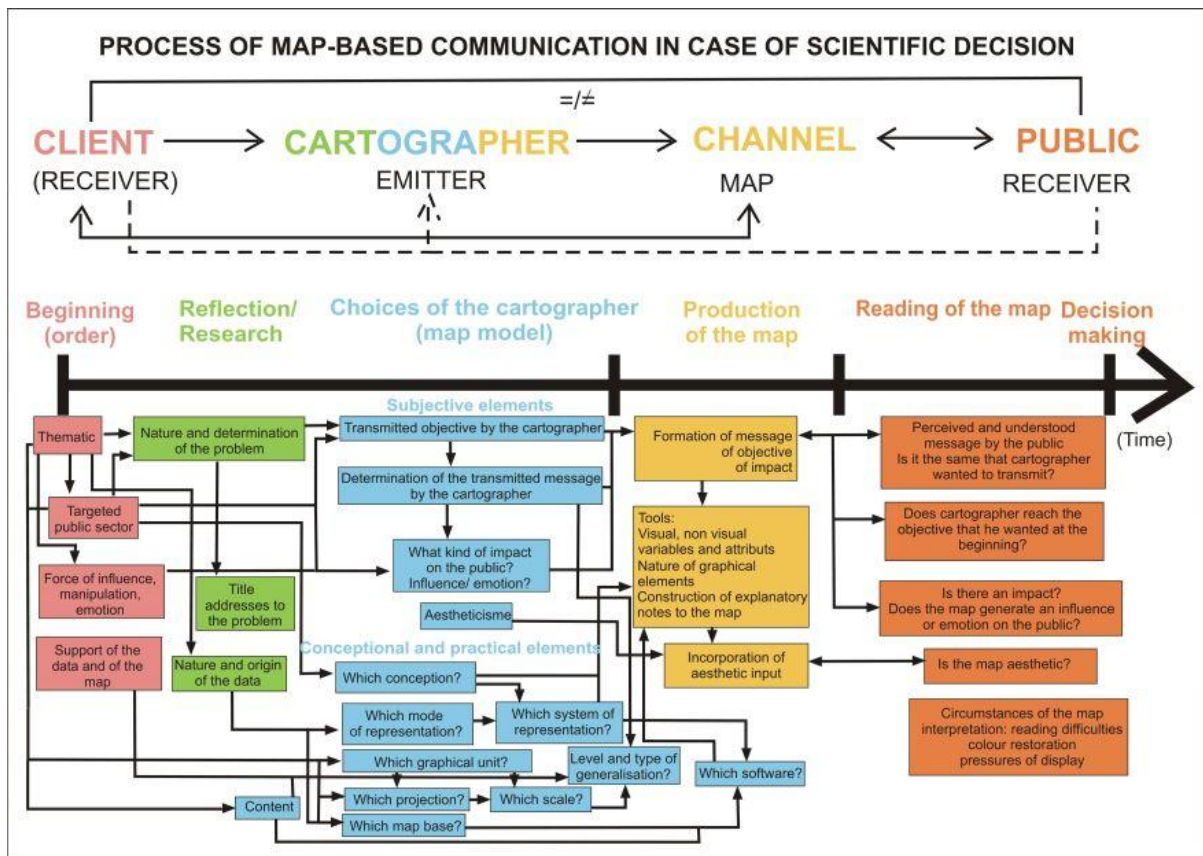


Figure 1 Model of cartographic communication

Using this example, we created a model of cartographic communication (Figure 1) which considers every communication factor that can influence decision making and user's reactions to the treated issue. To create our model, we were relying on Robinson's and Kolacny's map communication models. (Robinson, 1975; Koláčny, 1969). In our model we can distinguish three workflow layers:

A) Actors of cartographic communication

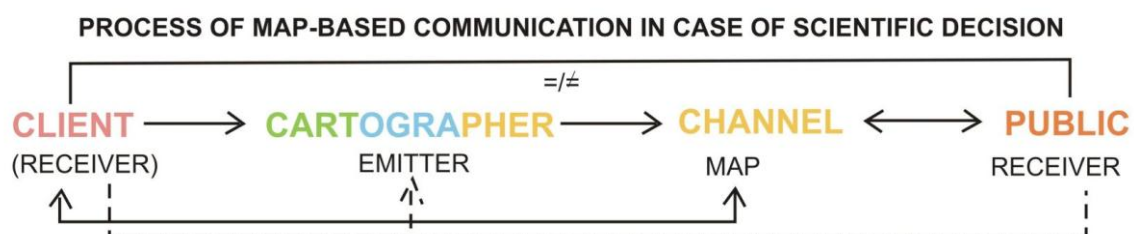


Figure 2 Actors of cartographic communication

The first stage (Figure 2) describes the relationship between the client, the cartographer, the public and the map.

B) Stages of map-based communication

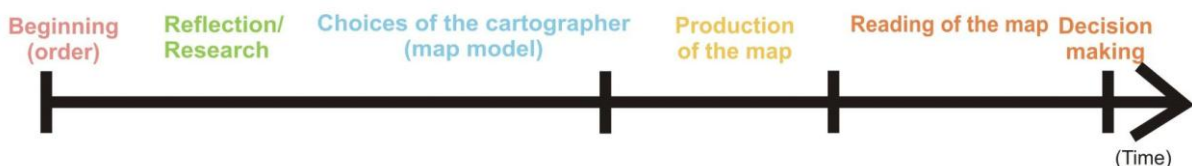


Figure 3 Stages of map-based communication

In the second linear scale (Figure 3) we can see the phases of map production, arriving to a map-based decision-making.

C) Influential factors of communication

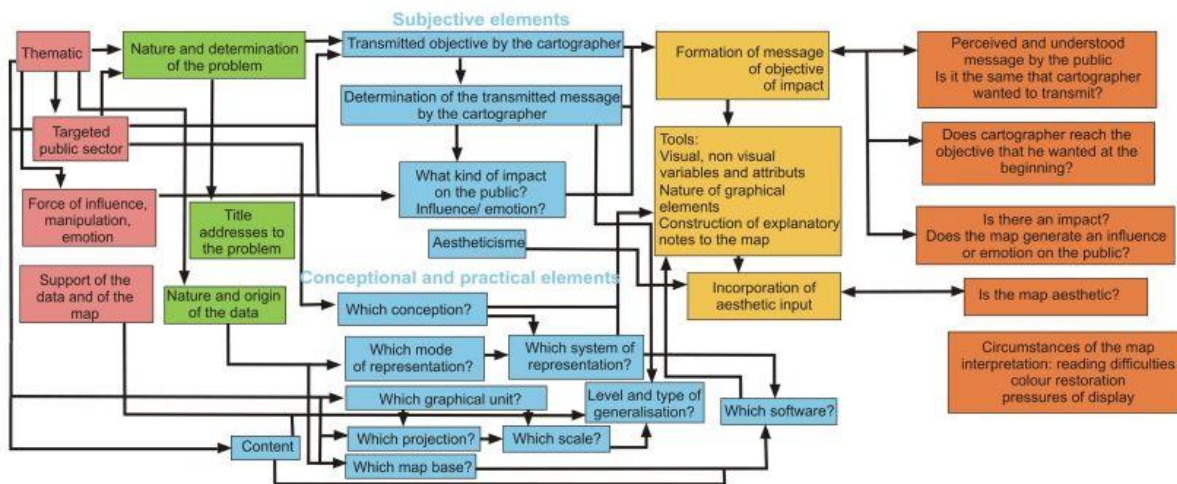


Figure 4 Influential factors of communication

In the third parallel dimension (Figure 4) we find all factors which determine that the transmitted information by the cartographer is well-perceptible and correctly understandable by the map reader.

The model also analyses the relationships between the elements of communication, and it tries to create coherence between the actors of this communication, where each factor can have an influence on the transmission of cartographical information.

A) Actors of cartographic communication

To understand what the demands of different users are, it is essential to analyse how information circulates between cartographer and map user. Cartographic communication is based on the emitter, who is the cartographer; the channel, which is the map; and the receiver, who is the map-reader. (Cauvin, 2007) There might be another actor who can influence this process: the client, who orders the map. Whether there is a client or not depends on whether the people who order the map are the same as the people who will read the map. If they are the same people, the client corresponds with the receiver. If not, the two roles have to be separated. In the case of maps produced to address water-related directives, the customer is the European Commission, but the reader is three different public sectors: decision-makers, experts, and the general public.

B) Stages of map-based communication

The processes of communication are achieved in different phases:

Beginning

Every map production starts with the order, which lays down the basic requirements that the cartographer has to keep in view during the map creation. These demands are usually independent of the map maker and fixed by the client. Therefore in the following phase, where the cartographer takes over the map production, his work is already delimited, and thus he has to adopt the circumstances in his train of thought.

Reflection/Research

The cartographer then has to research and reflect on the subject that he intends to represent.

Choices of the cartographer

In the following stages the cartographer faces the constraint of choices; he has to consider how the issue under consideration will be represented on the map.

Production of the map

With this complete, the map maker has to carry out all his ideas in a map-based graphical form, respecting the cartographic rules. The map has a key role in this communication; it is the realisation of the cross-section of cartographer's and map user's reality. (Koláčný, 1969)

Reading of map/Decision making

Finally the cartographer's work is validated by the user who reads the map, which will serve as a basis in the decision that the targeted public sphere will make. Map reading is not always followed by decision making, maps can also applied to make observations.

C) Influential factors of communication

In the third part of our model we can find the complex system of elements which can influence the reading, understanding and perceiving of the information transmitted on a map.

Beginning/Order (Figure 5)

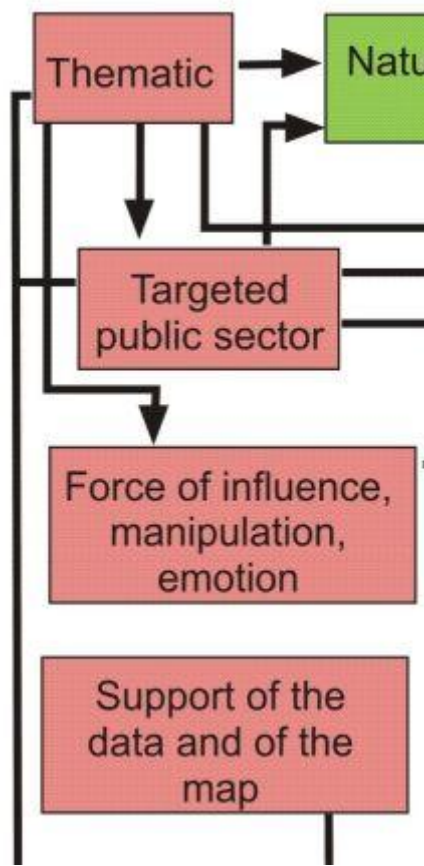


Figure 5 Beginning

Thematic/Targeted public sector

At the time of placing the order the client defines the theme of the maps and the public target. These two basic facts have the most impacts on the map production and even between these two elements there is an important relationship. Usually the theme dictates the public sector to be targeted. For example hydrological maps are generally aimed at hydrologists. In our situation, water-related maps particularly focus on experts in water as the targeted public sphere. On the other hand, knowing that these maps are prepared for a request by the European Commission, it suggests to us that decision makers are involved as well. But the fact, that laypeople are also targeted by these maps, is not obvious.

Force of influence

In this same phase we can find two other elements which can be determined by the customer. The cartographer can be requested to influence the map reader in a negative or positive way (Monmonier, 1996), or to add a manipulative or emotional character to the map. For example a client might ask that some important data which can harm safety interests, be represented in a moderate way.

Support of map

The customer can also specify whether he would prefer a digital or a paper-based map.

Reflection/Research (Figure 6)

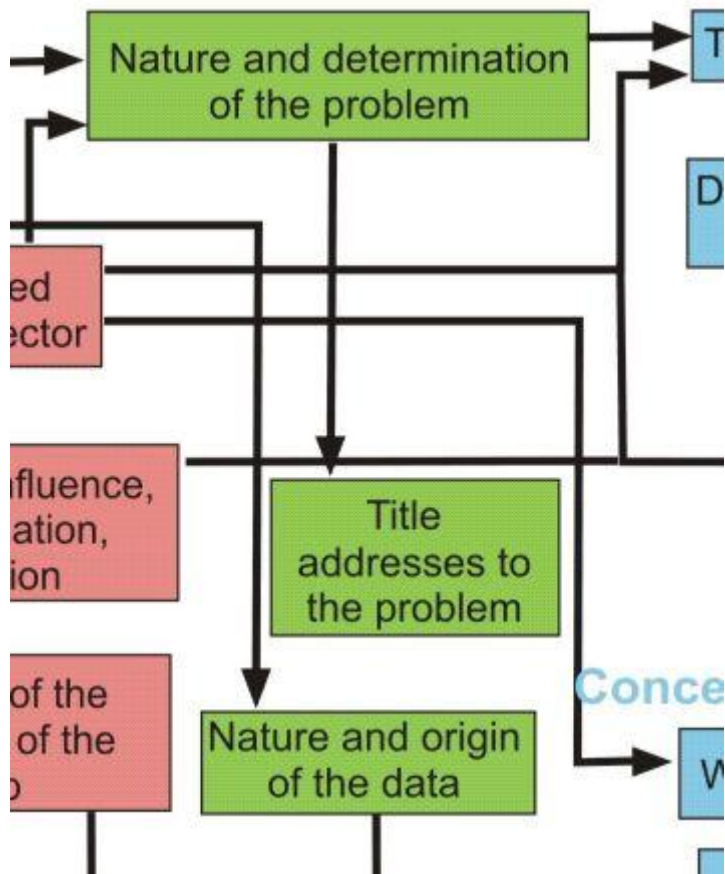


Figure 6 Stages of reflection and research
 Determination of the problem/Title

The next step is the stage of reflection and research. During this stage the cartographer has to determine the problem, which the map is intended to address. This problem is a function of the targeted audience and of the theme. A good title has to encapsulate the problem addressed by the map (Sidot, 2003).

Nature and origin of data

During the research, the cartographer has to find the appropriate data which can be used best to represent the issue.

Choices of the cartographer: map model (Figure 7)

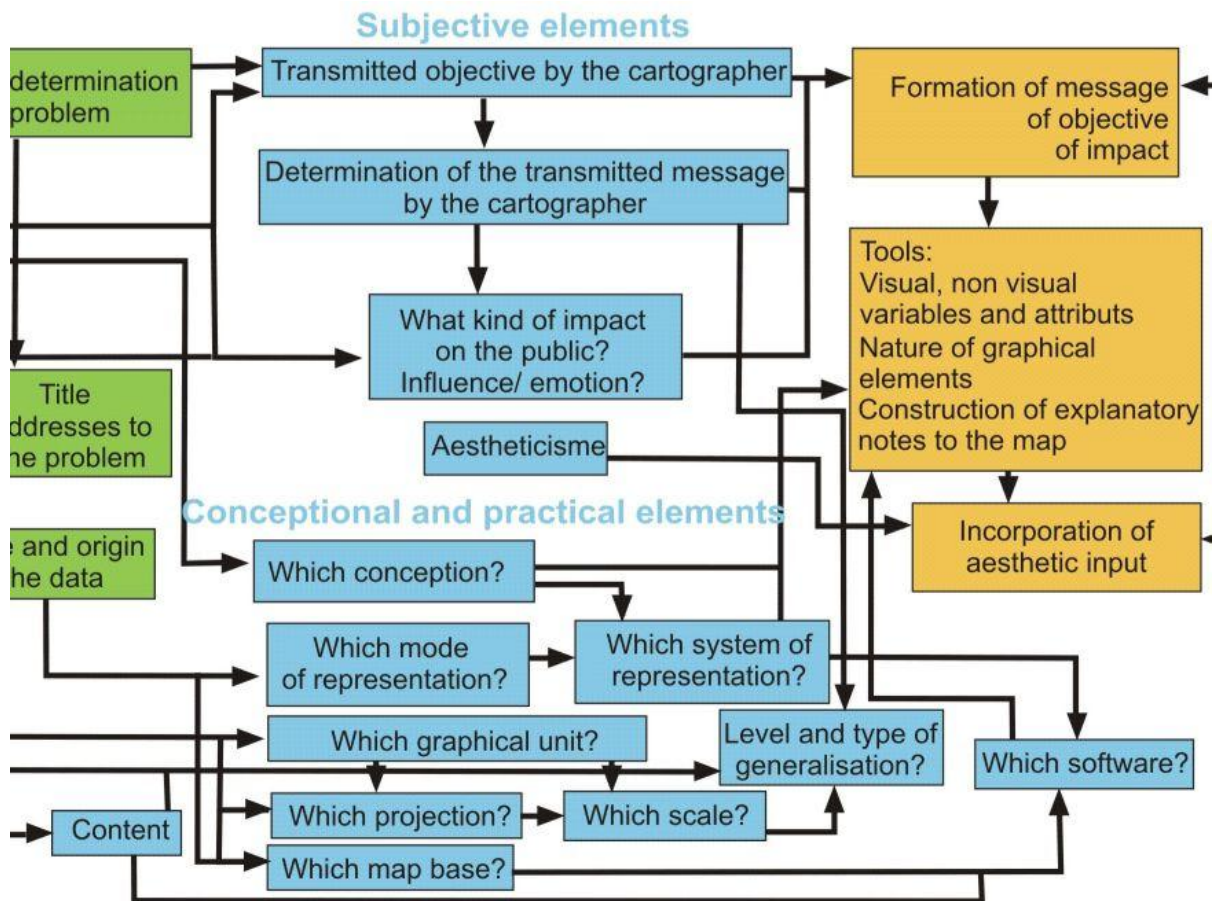


Figure 7 Choices of the cartographer

Subjective elements: Objective/Message/Impact/Aestheticism

Once the emitter has determined the problem the map must address, he/she has to make choices concerning the elements, which will characterise the map appearance. He/she has to decide on two main groups of elements. Elements such as the objective, message, (Cauvin, 2007) impact and aesthetics may be perceived in different ways, which do not correspond either to the intention of the cartographer, or the understanding of the user. These elements cannot be conceived on the map physically; they are determined by the totality of the graphical elements that construct the map. All these subjective factors depend on the components mentioned in Beginning and Research/reflection phases of map production. Evidently the objective, the message and positive or negative impressions are also connected. Thus the objectives determine the message, and the message will suggest what kind of emotion or influence the map has to impart to the map reader.

Conceptual and practical elements

The other group of elements that the cartographer has to choose comprise the practical and conceptual elements. These map production criteria form a system in the system of communication.

Content

The theme and the support of the map define the content: static, dynamic or real-time map. The content will have a real impact on the choice of the adequate software.

Conception

The conception, which means the number of themes represented and their relationship, (Quodverte, 2009) is determined by the theme and the targeted public sector.

Mode of representation

Several modes of representation are known in cartography. (Sign method, cartogram method, isoline method) (Klinghammer, 1991) These modes are based on cartographic rules which defined by the nature of the data treated. For example, in case of absolute quantitative data, the representation is with graduated punctual symbols. (Cauvin, 2007)

System of representation

The mode of representation and the map conception specify the system of representation. System is defined by J de Rosnay (1975) as follows "A system is a set of elements dynamically interacting and organized in relation to a goal." Another definition given by R. L. Ackoff (1972) is "...a system is an entity which is composed of at least two elements and a relation that holds between each of its elements and at least one other element in the set. Each of a system's elements is connected to every other element, directly or indirectly..." A map can function as a system of representation (Shin, 2006); every map has its own representation system which means the complexity of semiology graphic rules and visual variables. There are maps which have very simple systems and others which incorporate a very complicated system (synthetic maps with different kinds of mode of representation).

Geographical unit

The geographical unit depends on mainly the treated issue. Meanwhile the geographical unit places the theme in a spatial environment.

Projection

The thematic and the geographical units are those elements of the map which affect the choice of the projection. For example, if the extension of the subject is important, the projection type has to be an equal-area projection, and if the zone that we represent is near to the equator then it is most likely that we have to choose a cylindrical projection. (Stegena, 1975)

Scale

The projection and the extension of the graphical unit determine the scale of the map

Generalisation

The definition of generalisation by the International Cartographic Association (ICA) was "The selection and simplified representation of detail appropriate to the scale and/or purpose of a map" (ICA, 1973). According to this definition, the level and type of generalisation depends on the scale or on the purpose of the map but the map support can also determine the generalisation level.

Map base

Three kinds of map base are possible: it can be either an administrative, a geographical background map or a geometrical grid map. (Klinghammer, 1991) The targeted public sector should be considered before choosing the map base, as well as the thematic and the type of data influence the selection of the reference map.

Software

The chosen softwares have to comply with the demands of the cartographer, such that the map preparation has to be achieved easily by the software. The elements which will most impact the software choice are the content, the map base and the system of representation.

Production of the map (Figure 8)

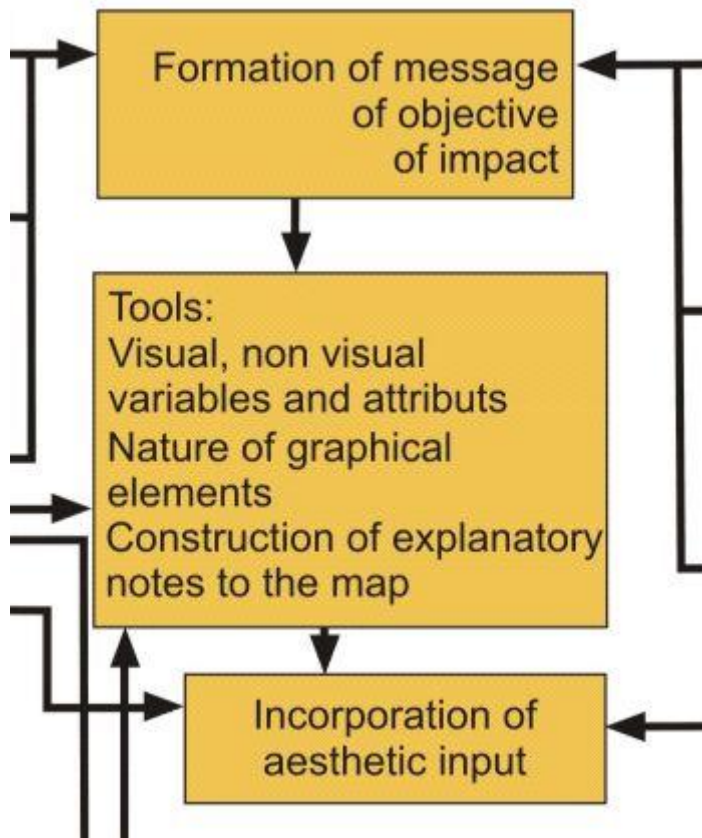


Figure 8 Phases of the map production

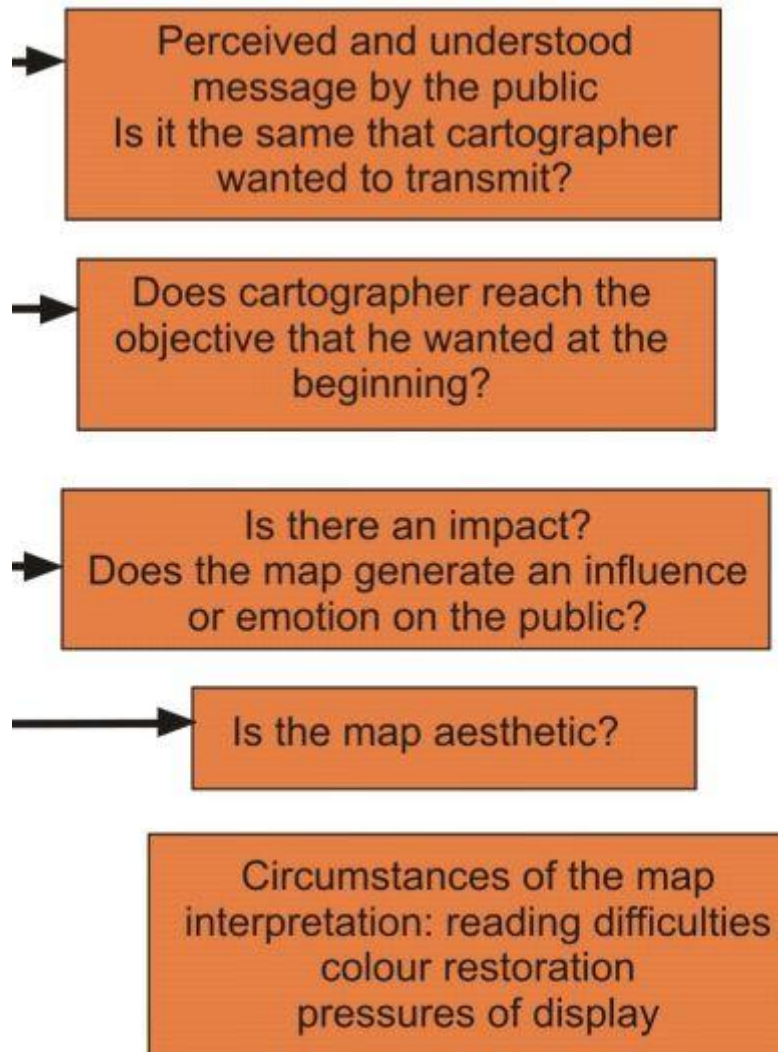
Formation of message, objective and impact/Tools of representation

The previous communication step is followed by the preparation of the map. This is the stage where the message, objective and the impact of the maps arise, which means that once the cartographer has chosen how and what to represent, he/she has to undertake it using the complexity of visual (Beritn J., 1967) and other variables (Cauvin, 2008) whilst respecting the rules of graphical semiology, and with help of these tools the map producer can express graphically what the message, objective or impact of the map. This is the phase where the cartographer has the possibility to introduce innovations. Innovations can be integrated with the introduction of new variables but also with the infinitive variant of traditional variables.

Incorporation of aesthetic inputs

Also in this phase the aesthetic inputs are required to be represented. The aesthetic representation is achieved by variables which build up the map.

Reading of the map/Decision making (Figure 9)



*Figure 9 Influencing factors of map reading and decision making
Perceived and understood message by the public/Reached or not reached objective/Impact on the public/Perception of aesthetic characters?*

Finally, in the last stage of the map-based communication when the reader receives the map, the cartographer's work is validated. The reading of the map is in two distinct steps:

- First the map has to be perceived globally. It is in this context that the aesthetic map features are discovered.
- Secondly, the map has to permit an excellent quality of reading: a good hierarchy of the colours or the grey values and the capacity of the good differentiation of the graphic elements. (Quodverte, 2009)

The shorter the amount of time the user takes to understand the map, the better the map. A good map determines how well a map communicates the pieces of information to the audience. (Foote, 1995)

Circumstances of the map interpretation

This is the final point of communication in case of decision. The conditions in which the map is read can have a real affect on the appreciation of the map and can result incorrect decisions. For example the map reading in a dark room or in a brighten room can give different results.

APPLICATION OF THE METHOD IN A RUNNING PROJECT

We are planning to create map prototypes in the frame of these directives targeting the three public sectors. These prototypes will be shown to the different audiences in order to verify the propriety of our models. These experiences will permit us to amend and develop our models.

After creating this model, in the next step of our researches we have to prove that this is a real working model in case of water-related subjects.

Beginning/Order

Thematic

Following our model, the first thing that we have to do is choose the topic. Water Framework Directive and Flood Directive present numerous water-related themes to represent on a map (EC, 2000, 2007). That is why we decided to try our model on a water-related theme which has an importance in both directives. The threat of want of drinking water or polluted drinking water in case of floods plays a real key-issue, which concern humans directly. Drinking water is one of the important subjects of WFD, and human health is strategic issue of FD. It seems to be an interesting issue from the aspects of the two directives, and it is not just interesting but relevant as well. People are usually the most afraid of disasters that threaten them directly. Drinking water is an essential of life, so the lack of water or the prospect of polluted water is a serious danger for people. These reasons lend support to the problem of drinking water as a relevant topic to check the correctness of our model.

Targeted public sector

The targeted audiences are defined by the directives: decision-makers, experts, and the general public. In future, during map production we have to consider that different public spheres have different demands, but also different attitude to the same issue. In case of floods, there are people who are aware that flood is a hazard, but there are others who think that a flood cannot arrive during their lifetime.

Force of influence

The question of influence, manipulation and emotion has an important role in case of floods and pollution. A balance has to be found between not making people afraid and warning them about the hazard of flood and the possibility of interruption to the drinking water network.

Support of data

We are preparing maps for digital- and paper-based environments.

Reflection/Research

Determination of the problem/Title/ Nature and origin of data

We are at the moment in this phase, and are searching for relevant data for the representation of our topic and also existing examples. (CG Hauts-de-Seine, 2010)

Choices of the cartographer: map model

Subjective elements: Objective/Message/Impact/Aestheticism

The objective is different for different audiences. For the decision makers it is to show that in case of different floods where a possible interruption of the drinking water system is expected. For the experts it is also to show the reasons of the interruption of the drinking water system. For the general public, it is to show whether his house is likely to be affected or not.

Conceptual and practical elements

Different public spheres have different demands in case of a map. Decision makers need maps which have simple system of representation as they have not always experienced with map reading, and they usually have to filter easy answers: no or yes. Do they have to take steps to turn off the drinking water supply or not? For the experts, more complicated map representations can be achieved as they possess map reading skills. The general public, like decision makers, need simple attractive maps with an easy system of variables. (Quodverte, 2009) We are planning to prepare a series of maps as one map is not always enough to explain an issue.

Nowadays, when INSPIRE directive (INfrastructure for SPatial InfoRmation in Europe) gives the frame of spatial data production (EC, 2007), it is important that our maps would be harmonised and usable in all of Europe. That is also one of the reasons that we choose Hungary and the Loire-Bretagne basin of France as our test areas.

Production of the map

For this part of the map production the same rules are true as conceptual and practical elements. Decision makers and the general public require maps with simple symbolisation while experts are able to understand complex maps.

Reading of the map/Decision making

We will validate the propriety of our model by sending the maps with questionnaire forms to the three different audiences.

PERSPECTIVES

The understanding of cartographical communication is the way to understand the origin of map-based decision-making. This is also solution to elucidating the demands of different users. Communication forms

a temporal and spatial underpinning to map production, but also relates to the classification of thematic maps. This means that all the communication factors define the criteria for the thematic map classification. Due to the appearance of European Commission computer technology and GIS, new elements were generated in the field of map-based communication, including the support of the data and maps, the background map (statistical grids), and visual and non-visual variables. These factors can be used to constrain a new thematic map classification.

In the future we will try to set up this new thematic map classification. It is also important to appreciate that, due to their roles in map-based communication, some of the elements of this classification may have a closer relation with others, so it will be possible to set up several two-dimensional classifications. For example, the nature of graphical objects (point, line, surface) and mode of their representation have a close relation so they can be analysed together.

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