The Role of Cartography in the GSDI World

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Key words:

SUMMARY

We would like to start with the important historian of cartography the Egyptian Prince Youssouf Kamal (1882-1952), editor of the *Monumenta cartographica Africae et Aegypti* (Cairo, 1926-51), which, in its 10 volumes showed the high level of Muslim cartography in the Middle Ages. It is not only based on Ptolemy, but also had original contributions, with works like the World map by al-Idrisi (see figure 1) and the Atlas of Islam (an atlas consisting of a series of maps that together represented all Muslim countries) by cartographers like al-Istakhri, al-Masudi, Ibn Hawkal and al-Biruni. The maps in these atlases are, to an important degree, characterized by their topological structure. They very much catered for the linear mode of travel that was customary in those days, and so they were very much adapted to their function. The offer of geospatial information must always be governed by the specific demand - but also by the nature of the terrain, or of the distribution of the population that inhabits the country.

A country like Egypt is a very good example of a state where it would be a waste of resources to map the whole country at the scale 1:25 000, as most of the country has a very low population density. The portrayal of the densely populated Nile valley and delta, however, would call for topological maps, as otherwise the various patterns in the population could not be shown adequately. It is the old Arab geographers that show us the way here.

The offer and demand for geospatial information is the central theme of our presentation. Nowadays we are able to provide enormous volumes of geospatial information, on the basis of which we can take better-informed decisions for use of natural resources, for environmental protection or for fighting disasters and their after-effects. But the ground truth is that we are only able to use them if they fit in our concepts, if we understand them properly, if they have been tailored to our needs. It is not enough to build a nice technical infrastructure without teaching the population how to use the maps, be they in analog or digital form. We have to provide the concepts with which the population is able to deal with geospatial information, and we have to provide maps from which the population is able to derive the information they need: information that is up-to date and tailor made for solving the problems.

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1. INTRODUCTION

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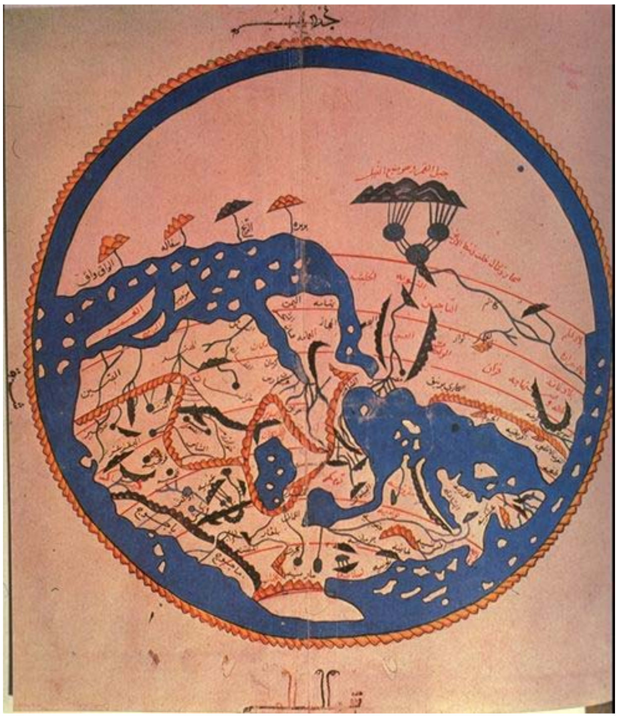

Figure 1 – World map by al-Idrisi

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2. STATE OF THE ART OF CARTOGRAPHY

Cartography is originally an instinctive science, which nowadays enters a new, revolutionary period of its development. In a modern approach, mapping is understood as the ability to create a knowledge frame of an environment in space. Even though it is in principle cognitive, cartography has traditionally transmitted knowledge mostly with the use of paper products that expressed geospatial ideas and allowed storage and transfer of spatial information. Later on, maps started to be used for research and analyses of more and more complex spatial problems in scientific work and in the society. Paper maps have many positive features and over the centuries, they have been able to derive benefit from technological development. However, until recently, all paper maps lacked dynamic and interactive flexibility of their cognitive alternatives (Wood 2003).

Already our ancestors possessed basic mapping skills, which enabled them to record knowledge of their environment, and increasingly, they were also able to construct and draw their own simple cognitive "maps" in the sand, dirt, and later also in other materials, such as tusks (in Moravia, perhaps the oldest map in the world was discovered; it dates back to 24,000 B.C.). This ability remains anchored in the human mind. Together with technological development, we could see emerging a sort of specialists (professionals) creating maps and a discipline called cartography. Its task was to create formal map products with a certain quality level and a certain value. After an evolution lasting for many centuries, cartography has reached the status of a discipline that helps to understand the geography of the world. The development of cognitive mapping based on the perception of the environment and the perception mediated by cartographic products, or in other words the creation of maps and the use of maps, have evolved separately for centuries.

Computer technology has started to influence cartography since the mid 20th century. This influence resulted into the appearance of two contrasting tendencies: a) attempts of scientists working with spatial information to create computer cartography as a tool for supporting data research and analysis, which have later resulted in the creation of Geographic information systems (GIS), and b) more limited use of computer-assisted methods in cartography for conversion of analogue maps into digital maps in order to facilitate and quicken the process of their production (Wood 2003).

The creation of GIS in particular has significantly influenced the new stage of cartography development. GIS were not designed in order to reach a higher level of mapping quality; the virtual "point-line-area" structures that they contain can be interconnected with attribute databases and symbol sources; Kraak and Ormeling (2002) speak about digital landscape and cartographic models, which are basically cartographic. Nowadays, GIS systems support a wide range of spatial projects; however, creation of maps remains the independent and dominant conception. GISystems have not replaced cartography; they have equipped it with exceptionally successful technologies providing a higher level of perfection and efficiency.

The influence of GIS in cartography has been obvious especially in the past 15 years in the form of the emergence of a new generation of electronic maps and atlases, mainly on the Internet, which resulted in the definition of multimedia cartography. According to Cartwright (2004), multimedia, global communication systems, and global publishing offer possibilities for the production of dynamic and interactive visualizations, which utilize mainly virtual environments (developed originally for the computer games industry).

The development of cognitive mapping requires the provision of open two-way live connection between thinking and data with a supporting interfacing tool. This should enable flexible research utilizing many data sources. Maximum potential is reached by simultaneous implementation of dynamic, interactive and multimedia tools, implicit in a model called Interactive space human-map (see Fig.2).

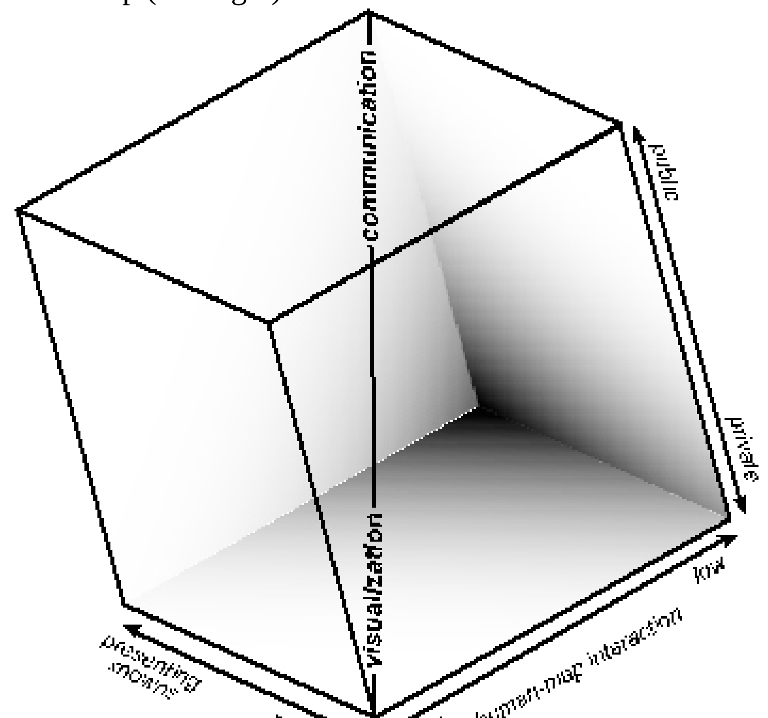

Figure 2 - The Map use cube showing four forms of visualization for exploration. Analysis and Presentation (according to A.M. MacEachren, 1995)

Nowadays, intelligent access to databases and interactive user support can be used not only for the location of suitable maps on the Internet, but also for map creation and modification according to *specific and individual requirements*. Instead of just *using maps* that were created by someone else in advance, these new research technologies allow individuals to use cartography interactively, *on the basis of individual user's requirement,* to study and present spatial information. New technologies allow "live connection" between the instinctive inner sphere of our cognition and - via direct interaction - new generation of cartographic visualizations and thereby also with the almost infinite resources of the Internet.

Cartographic visualization is a set of map-related graphic procedures for analysis of geospatial data and information. For example, an animated interactive digital model of terrain is a form of cartographic visualization. Cartographic visualization provides for a wide range of interpretation and representation possibilities. If they are applied on varied reference data related to earth surface, we use the term geovisualization. The global leader in the above mentioned activities is the ICA Commission on Visualization and Virtual Environments. Their work, the development of new visualization methods is far from finished. It is necessary to deepen and refine it, and create it also with the help of other scientific fields, especially mathematics and statistics, aimed at the creation of tools, which are able to operate also with fuzzy data or indeterminacies in databases and real models built on such databases.

Under influence of the information and communication technologies, another stream in cartography has been created, so called ubiquitous mapping. They are based on the emergence of new communication modes, specifying relations between cartography and GIS. As consequences Takashi Morita (2004) describes the basic nature of map as:

- they *provide the framework of location*: relative location (relationship with landmarks) and absolute location (coordinate system),
- they visually present the data and allow for the rapid recognition of patterns,
- they allow for Human-Map-Space Interaction: as shown above this ability has existed from the early age of mankind, but now it has accelerated, was facilitated and stimulated by IT.

He also defines the differences between GIS and Maps. GIS means data input, database building, data analysis and data output for spatial information. Mapping includes not only map making, but also map use and map communication, as it considers the interaction between map, spatial image and the real world. GIS is system function oriented, whereas Map is human-oriented, including spatial cognition, decision making and communication.

Changes in our external environment are characterized by visualization and ubiquitous computing possibilities. The first steps in the era of the Information/Knowledge-based Society are characterized by the shift from the contemporary use of radio to TV and to the Internet, by visualization of printing media and visualization of information in terminal devices. The later developments are based on the existence of many computers everywhere, mobile equipments, e-initiatives (like e-Government) as well as on relations of person to person, of person to machine, of machine to machine (machine communication: network, human communication: understanding).

Through this process, the Ubiquitous nature of map is extended as follows: 1. In Visual perception it allows us to see any part of the image, to recognize the whole image (pattern recognition), the thematic image and background and to represent alternative visualisations of the same image. 2. In the Production process, it allows us to generate and create these images anywhere. 3. In the map Use process: it allows us to bring map anywhere, to receive existing maps anywhere, and use them anywhere.

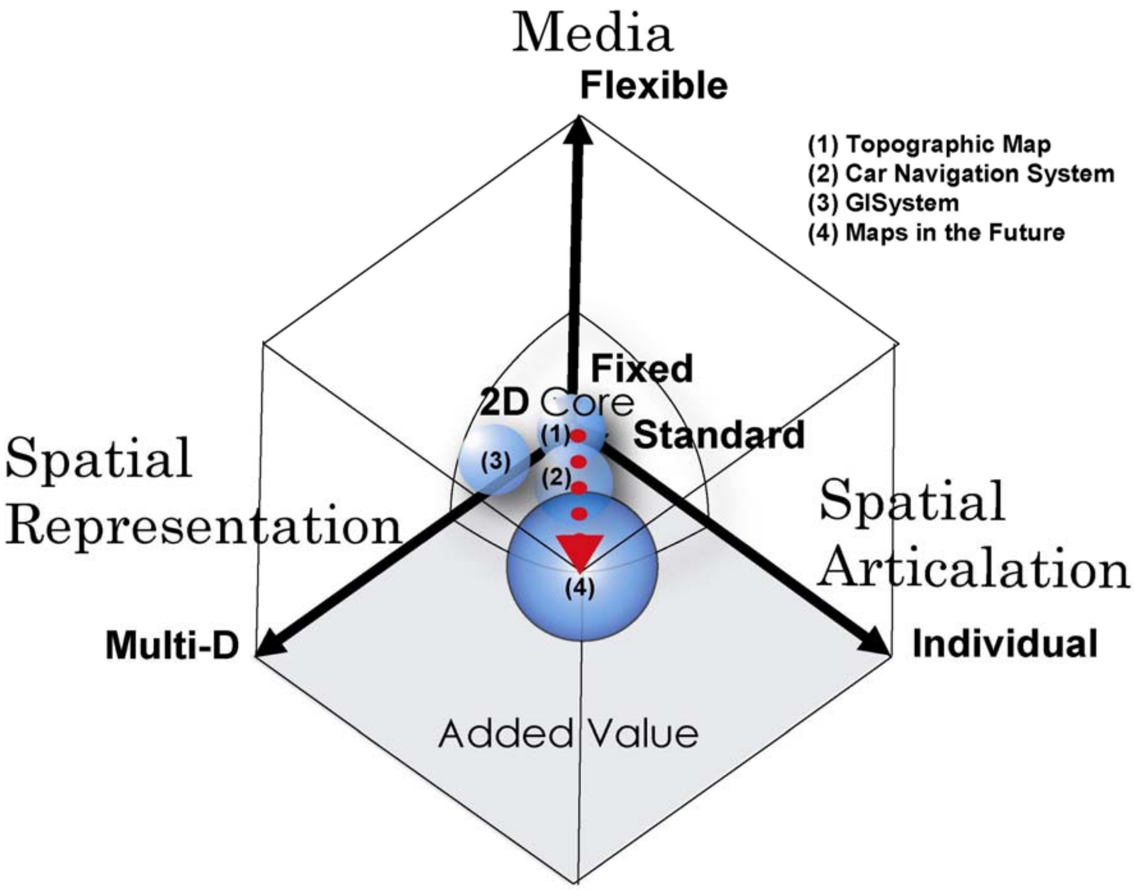

Figure 3 - Mapping World (according to T. Morita 2005)

The third stream in contemporary cartography is represented by Internet maps. Michael Peterson (2005) is highlighting the fact that the Internet is redefining how maps are used. Maps on the Internet are more interactive. They may be constructed by interacting with an online database, thus engaging the map user on a higher level than is possible with a map on paper. In addition, the Internet is making it feasible to more easily distribute different kinds of cartographic displays such as animations. The Internet presents the map user with both a faster method of map distribution and different forms of human-map interaction. Peterson describes also reasons why Maps on the Web are so popular. “It is easy to understand why maps are distributed through the Internet. Printing on paper is expensive, especially in large format and in colour. Once the infrastructure is in place, it is simply less expensive to place colour graphics on the Web than it is to print on paper. When the additional costs of shipping and distribution are factored into the printed product, the cost advantages of distributing maps and images over the Internet become even more apparent. The main advantage of printing, however, are resolution and overview. To overcome the limitation of "spatial resolution," maps displayed by computer are typically more dynamic. The maps are frequently updated, they incorporate some type of interaction functionality such as zooming, or a series of maps can be viewed as an animation. The combination of maps and the Internet is a significant development, not only for improving the distribution of maps but also because it makes a more interactive form of mapping possible. "

3. (G)SDI WORLD: WILL TECHNOLOGICAL PERFECTIONISM BE ABLE TO ANSWER SOCIETY'S REQUESTS?

3.1 INSPIRE

These data that cartography can offer have to be distributed, and here the Spatial Data Infrastructure becomes the *condition sine qua non*, if we want access to the geospatial information anywhere anytime. Nowadays a so called legislative initiative called INSPIRE (Information for Spatial Data in Europe) is discussed in the European Parliament. Many of the aspects of this initiative which have been started originally by the Directorate General for the Environment of the European Union, were oriented to users, including initially also representatives of Eurogeographics and some other organizations. Three important words can characterize this initiative: data availability, data access and providing the legal conditions to ensure this process.

The INSPIRE concept is based on a new approach for providing geographical information on both national and European level. The call for a new approach is based on the notion of availability and usability of information as a base for policymaking etc. INSPIRE's main short-term goal is to support the legislation process in the European Union environmental policy. It is a fact that all themes of environmental policy (water, air, climate, soil, biodiversity, etc.) *have a common spatial dimension*. This spatial dimension is very important for both environmental and other sector policies and geographical information, and therefore it needs to be *integrated* in a common information infrastructure.

The process of the creation of INSPIRE has to be based on a *co-operative* approach where activities on *different levels* and *in different sectors* are co-ordinated in order to make relevant information available ; this also requires co-ordination between *local and national systems and systems on a European level*. Finally, integration of information between a broad range of sectors (transport, agriculture etc) along with its implementation in the environmental sector is expected.

There are Six fundamental principles of INSPIRE:

1) Data should be collected once and maintained at the level where this can be done most effectively.
2) It should be possible to combine seamlessly spatial information from different sources across Europe

3) It should be possible for information collected at one level to be shared between all the different levels, in detail for detailed investigations, general for strategic purposes.
4) Geographic information needed for good governance at all levels should be abundant under conditions that do not restrict its extensive use.
5) It should be easy to discover which information is available, fits the needs for a particular use and under which conditions it can be acquired and used.
6) Geographic data should become easy to understand and interpret because it can be visualized within the appropriate context selected in a user-friendly way.

3.2 GSDI effort

Now what is valid for Europe also should have some global validity, and we think it could strengthen the GSDI mission. The Global Spatial Data Infrastructure supports ready global access to geographic information. This is achieved through the coordinated actions of nations and organizations that promote awareness and implementation of complementary policies, common standards, and effective mechanisms for the development and availability of interoperable digital geographic data and technologies to support decision making at all scales for multiple purposes. These actions encompass the policies, organizational remits, data, technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the global and regional scale are not impeded in meeting their objectives. These GSDI ideas are realized by 3 working groups, **a Technical Working Group, a Legal and Economic Working Group:** and a **Decision Support Working Group:**
The activities of regional SDIs and as well as GSDI are very important and unreplacable. All regional initiatives are carefully looking and if possible participating in the GSDI activities. Without guaranteed access (in sensu lato meaning) to the geospatial data and information also the cartographical ambitions to be part of the game will be hard to reach. So there is much at stake for us cartographers as well.

4. LESSONS FROM DISASTER MANAGEMENT SITUATIONS

The recent tsunami disaster in the Indian Ocean demonstrated the extent that ICTs (information and communication technologies) can contribute to emergency response and disaster reduction. The use of spatial (incl. cartographical) and space technologies has been proven useful in the risk assessment, mitigation and preparedness phases of disaster management. As the global community learnt from the tsunami event, spatial and space technologies have also a central role to play in providing early warning to communities that are at risk. But in order for developing countries to be able to incorporate the use of space and spatial technology-based solutions there is a need to increase awareness, build national capacity and also develop solutions that are customised and appropriate to the needs of the developing world. Jan Egeland, Under-secretary of UN, used at the time of his opening speech in The World Conference on Disaster Reduction, which took place in Kobe from 18-22 January 2005 a famous Japanese proverb that reminds us that: “Vision without action is but a daydream; action without vision is a nightmare.”

He enhanced that as the tsunami tragedy has shown us, local disasters can have global impact. It has also reminded us that global risks require truly global solutions. He urged to adopt as soon as possible clear indicators for building disaster-resilience at the local and at the global level. He enhanced that Disaster reduction is not simply a matter of sophisticated technology and hardware; at root, it is also a matter of communication and education., we need a global early warning system. But let us remember: technology is not a cure-all. From Singapore to South Africa, he said, experience shows us that people, not hardware, must be at the centre of any successful disaster warning and preparedness measures. He also requested to radically revise our development models so that reducing and managing risk becomes central to sustainable development policy.

The Kobe conference accepted several documents incl. the *Hyogo Declaration* in which it was recognized as well that a **culture** of disaster prevention and resilience, and associated pre-disaster strategies, must be fostered at all levels, ranging from the individual to the international levels. Human societies have to live with the risk of hazards posed by nature.

In another document, the *Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters* the Conference has adopted the following five priorities for action:

1. Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.
2. Identify, assess and monitor disaster risks and enhance early warning.
3. Use knowledge, innovation and education to build a culture of safety and
4. Reduce the underlying risk factors.
5. Strengthen disaster preparedness for effective response at all levels.

Point 2 of the above mentioned priorities in paragraph 17 says: „The starting point for reducing disaster risk and for promoting a culture of disaster resilience lies in the knowledge of the hazards and the physical, social, economic and environmental vulnerabilities to disasters that most societies face, and of the ways in which hazards and vulnerabilities are changing in the short and long term, followed by action taken on the basis of that knowledge. The following *Key* activities for realization of the topic in the field of National and local risk assessments were formulated:

(a) Develop, update periodically and widely disseminate **risk maps** and related information to decision-makers, the general public and communities at risk in an appropriate format.
(b) Develop systems of indicators of disaster risk and vulnerability at national and sub-national scales that will enable decision-makers to assess the impact of disasters on social, economic and environmental conditions and disseminate the results to decisionmakers, the public and populations at risk.
(c) Record, analyse, summarize and disseminate statistical information on disaster occurrence, impacts and losses, on a regular bases through international, regional, national and local mechanisms.

The above mentioned topics could be linked with many others, but the GSDI potential and the Global Mapping potential are not enough visible, at least in conference documents. Is it some kind of ignorance or simply the fact that we are insufficiently able to offer our results in a way which will be a part of the **culture** of disaster prevention and resilience, and associated pre-disaster strategy (using the words of Hyogo Declaration)? May be one of the problem is that we still are too much concerned with the technological aspects but not enough with developing approaches towards people who needs all of our data for their everyday life, but also need to get them in a form they can understand.

Unfortunately, lessons from recent disaster management show that the decision makers that needed the geospatial information did not have access to it in time, nor in a form they were taught to deal with.

5. CARTOGRAPHICAL REALITIES AND POTENTIALS IN THE GSDI WORLD

Even in the Brave New World of GSDI, we will never be beyond cartography, as we will always start our knowledge of the world, making sense of it, structuring it, through the help of maps and atlases. It is in Alexandria, Egypt that the geographer Ptolemy first developed the idea of atlases: how to subdivide the world into 26 parts, how to portray the world in its entity and in parts. We are still using his ideas of subdividing the world, in parts from north to south and from west to east. We are only refining these ideas; instead of atlases, used when our knowledge of the world increased beyond what we could represent on single maps, we used systems of maps; in another geodata revolution, in the 19th century, we used national atlases; the next geodata revolution at the end of the 20th century led us to digital atlases. But still we keep these cartographic ideas of making sense of the world.

Examples of the atlas concept – atlases as ways of storage of geospatial information we have learned to deal with – are for instance emergency-atlases. Here in the first place atlases allow us access to the area involved, the atlas opens the door to that area, and allows also people faraway to understand its problems.

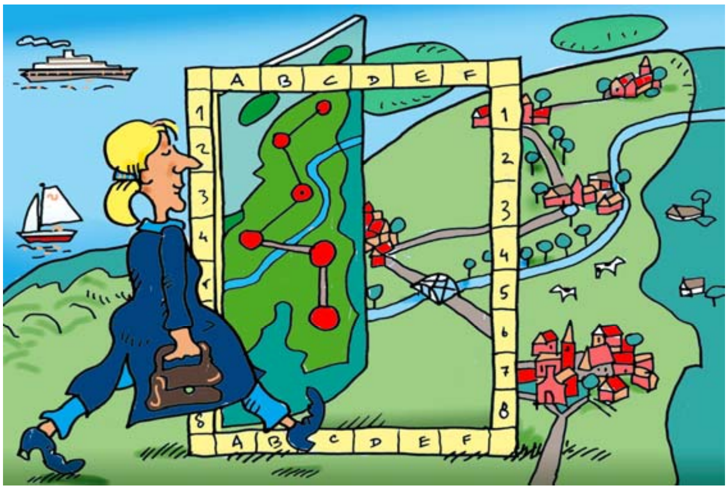

Figure 4 – The map as door to our environment, allowing access to geospatial data

The maps in atlases can be like geographic switchboards, through which to access metadata or other data the maps are based on. By clicking on a symbol on the map our telephone facility is connected with the emergency centre represented by that symbol. By clicking the maps we are also able to access these underlying files, so maps are ways of ordering and accessing information. A good example are the emergency atlases that now most regions have to prepare. They show the capacity of emergency services, they show escape routes, they show expected flood directions, based on dtm's, they show the number of people involved, the locations of the emergency rations, the locations suitable for food dropping or evacuation take-off. These emergency atlases are a prime example of the continued relevancy of the atlas concept, as they continue to bring together and integrate up-to date spatial information, tailored to the needs, easy to use, so that in emergencies no mistakes will be made.

Emergencies will not be our only concern in the future, there is a large task ahead of us to plan for sustainable development, analysing the masses of data that we collect nowadays. We have developed data mining techniques, and strictly speaking we can do so without using maps, but still maps make it so much more easy to conceptualize these efforts and check their results. New ideas for analyzing data, even non-spatial data through cartographic techniques are being worked out all the time; spatialization is another example. The institutional structure in which this development work is done is mostly bottom-up: ICA commissions and Working Groups (such as Early warning, Ubiquitous mapping, Visualization, Mapping and the Internet) decide for themselves how they go about solving the tasks that have been set to them, even if, like our Commission on Standards, they have to work within frameworks set by others.

Figure 5 – Illustration of digital map-assisted data mining

Perhaps above we have emphasized too much the technological frontiers of our profession. We should also stress that alone in the joint board, through geography teaching we also access primary and secondary education. Through our Cartography and children group we are able to influence the way school children all over the world view their environment, and learn to deal with the techniques to use geospatial information to solve problems. One of the aspects that come up there is the way our different cultures colour the way we look at geospatial data. Cartographic representation is never value-free or completely objective; the way we look at the world is like our first school atlases: we look from the perspective of our country to the wider continent and beyond, and we will continue doing so when the GSDI is being realised.

6. CONCLUSIONS

1. The Role of NMA's or NMCO's is very strong, and their power cannot be missed in the grandiose plans that have been developed for global data access and availability, especially as they also provide the reference data all other geospatial data have to be adjusted to.
2. At conferences in the last several years and as well as in interviews NMA bosses often use the word "beyond" in connection to mapping (beyond mapping, beyond cartography). It could be said that they meant that the required techniques they were envisaging were completely unlike the cartographic techniques they learned when young. They realise insufficiently that cartography and mapping are different now from analogue times. We should highlight that cartography has new technologies, new markets, new possibilities to customize geospatial information to individuals.

   The role of those building GSDI is too much an engineers approach, and engineers frequently just think that as long as you bring the information to those that must work with it, everything will be fine. But:

3. Cartography begins where SDI ends….Spatial data visualization by new technological tools (internet and Web, mobile, broad band, etc) makes no sense as long as the person at the end does not understand the imagery and cannot integrate it in her perception of reality, that is in her mental map. Cartography will continue to be essential there.

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