What Do We Want to Know About Map Use, Users and Use Environments

The editors organized a panel on Map Use for the Association of American Geographers Annual Meeting in 1996. The persons appearing on the panel were selected because they represent diversity in terms of interests in the broad realm of cartography and map use. Each panelist was asked to prepare a 10 minute presentation addressing: "What is it we want to know about map use, users, and use environments?" And, "what insights can you contribute to these questions based on your research and observations?"

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It was assumed that there would be a great amount of overlap in the panel presentations. Rather, each author brought a unique and insightful perspective. Because the papers were refreshingly unique and of such quality we decided each paper should stand by itself rather than be blended together in a summary of a panel discussion. These three papers grew out of that panel discussion.

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Map Use Steps and Their Data Quality Requirements

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We want to better understand geo-information production lines so that we can represent data quality concerns on our maps. And, we must be concerned that not only do we get the right data to the user but that the user gets the data right. We need research to find optimal geo-information production lines, to assess data quality, to link quality to intended uses, and to visualize the results in effective ways. This may involve using fuzzy and crisp symbols, or employing possibility and probability values.

INTRODUCTION

Map reading is not an isolated activity. It is part of a query and answer process that can be termed a geo-information production line (figure 1). When we want to solve some problem with spatial implications we collect spatial information, present it in a visualized form and by using the resulting map we hope to get an answer to a problem. The foundation of this production line is formed by a number of concepts such as a spherical earth, generalization, abstraction, etc.

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Map designers should have an integrated view of the whole geo-information production line, because their maps should accommodate users' need to correctly weigh and interpret the quality of the visualized data (figure 2). As noted in this model, cartographers should be aware of the nature of the data capture process as it affects data quality, and they should convey the nature of the data quality. This might be done by employing some objective quantifier like the number of samples or the distance between sample sites. The same can be said for the data analysis process - when we combine data sets or transform them, aggregate them or whatever - and here again we should indicate what happened to the data quality. The users should not only be informed about the quality of

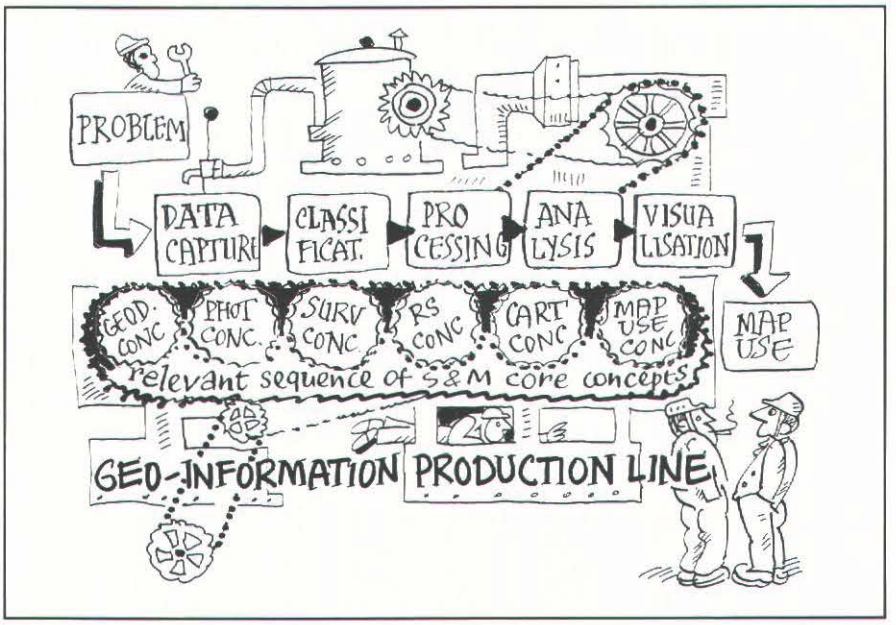

Figure 1. Geo-Information production line (by A. Lurvink, unpublished)

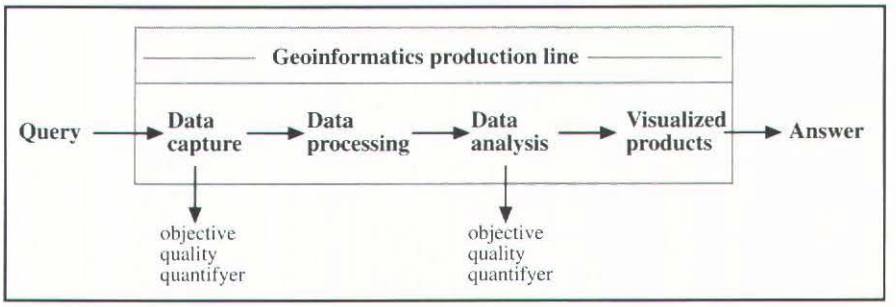

Figure 2. Formalized Geo-Information production line

the dataset as a whole, but also about local or regional anomalies in data quality, because they may want to select locations, corridors or regions that address specific requirements. To represent data quality, cartographers might classify map items as fuzzy or crisp, or employ possibility or probability values. Various techniques for visualizing data quality information have been developed by cartographers (see Van der Wel, et. al., 1994).

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To visualize accuracy of ratio-scale attribute data it is possible, for instance, to use differences in size; in order to show the accuracy of nominal data both color hue, orientation, texture or pattern would be suitable. These variables can either be rendered in a separate map presented next to the main map, or can be integrated with the main map - thus combining variables showing the contents - such as color hue - and variables showing the accuracy of the contents. It will make a difference whether these variables indicating data quality are used in a static or in a dynamic environment (Hootsmans, 1996). What is still missing in the research results cartographers have come up with is a concordance between specific quality visualization methods and types of spatial information use.

This concern with the visualization of data quality is just part of the more general issues: "how to get the user the right information", as well

as "how to make sure the user gets the information right". Few persons in geo-information, including cartographers, seem to realize that both of these tasks are equally important. It can be modeled with the modified geo-information production line in figure 3.

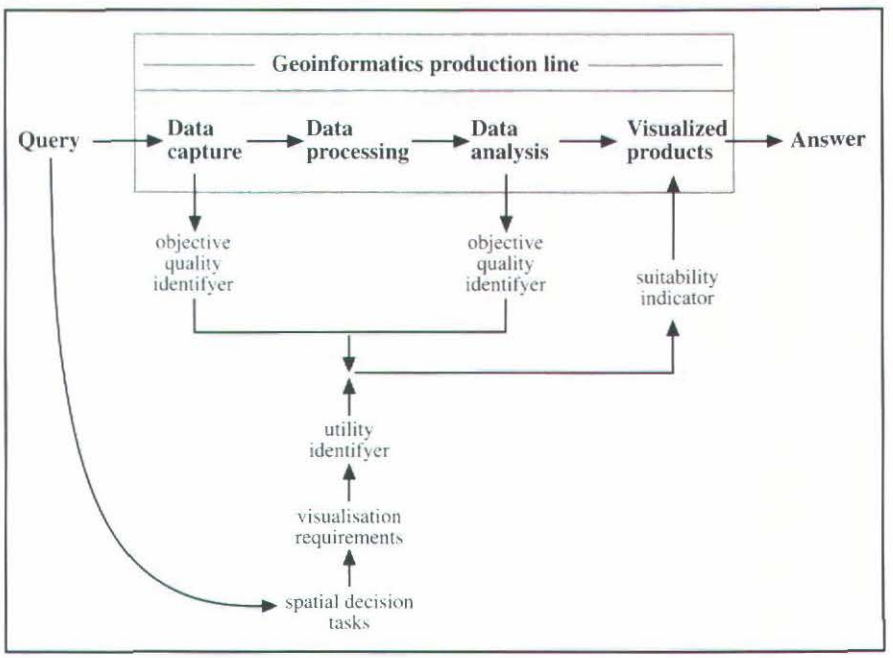

Figure 3. Modified formalized Geo-Information production line (taking account of visualization requirements of spatial decision making tasks)

Whether the information on the map is right should not only be decided by objective quality identifiers, but also by the kind of task to be performed with the information. This task will call for a specific visualization method, and the kind of use of the resulting image will determine the utility of the information with a specific objective quality. So the question would be, for example, how important is it, for a specific application, that the data are only 97% correct or that more than a third of the data points on the map are more than 3 m from their actual position in the field?

To ascertain these utility or suitability values we need to research all types of uses of visualized spatial information: what do people actually do with the visualized spatial information when they need to make decisions? If they want to know the situation at a specific point, their visualization requirements would be different from when they wish to see overall trends; when they want to compare themes, requirements will be different from when they want to use the map for orientation.

". . . what do people actually do with the visualized spatial information when they need to make decisions?"

If data quality is defined as fitness for use, then objective quality measures, like probability (for crisp classes) or possibility (for fuzzy classes) are not enough, but should be linked to some utility measure, showing or evaluating the desirability that data are up to standards for a specific use of the data. Spatial data uses may be identified in broad categories such as management, reference, navigation, etc. Each of these broad uses can be broken down into single actions or steps, such as locate, compare, count, estimate, etc. Each step will have its own requirements; for each map use step a specific image quality will have a specific utility. For a specific step a map with a regional probability value of 0.8 might be desirable for reading off suitable point locations. A land cover map with an overall possibility value of 0.7 might still be adequate to serve as a basis

for land use planning. Whether it actually is suitable would depend on the accuracy or data quality requirements for the individual map use steps.

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A map use task like navigating will consist of steps like: orient map, locate position, identify destination, determine route requirements, find optimal route, mark route, select landmarks, check landmarks, and verify destination. High absolute accuracy will be important for both finding the position and the destination on the map. For optimal route finding or for checking landmarks only relative accuracy is relevant.

The relevance of this subdivision into map use steps would be to adapt the visualized information to the task at hand. An interactive map use environment might enable us to change the map image as soon as tasks requiring specific data quality have been performed. This could have important implications for guided interactive map use exercises - as soon as correct answers have been given to specific questions, the data quality is adapted to the next question. Even when browsing, the data quality could be set to specific use modes, and the relevant quality concerns for that specific map use mode would be visualized.

Aspects of data quality other than fuzziness (similarity to the core of a fuzzy set) can be ambiguity (a measure of the difference between most likely and the second possibility), credibility (indicates the stability of boundaries of fuzzy spatial sets) or boundary certainty. When I want to locate boundaries between phenomena, I would like to use a quality map showing boundary certainty, probably represented with achromatic variables. When I would be more interested in identifying core areas then I would opt for visualization of fuzziness or ambiguity. In many cases I would expect to get a better opportunity for identifying core areas in an interactive display environment by using animated techniques - by manipulating fuzziness dispersion values with a slide bar for instance.

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So it is not only the type of information and its quality which will influence possibilities for use, but also the nature of the steps in the use of the map. If we can make certain the user or customer gets the right information, and gets this information right as well, then we have provided not only the map as our final product, but the whole geo-information production line with added value.

The types of research called for here consists of finding the optimal geo-information production lines, assessing data quality, linking these to the intended uses, and visualizing the results. Whether data quality visualization methods will ever be applied depends on the desire and willingness of map users to consider information on differences in data quality. For users, it is a question of perceived relevance. For those of us in the geo-information production process it is a matter of demonstrating the relevancy of data quality indicators as well as determining how to represent those differences in data quality.

REFERENCES

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