Communicating Data Certainty on Maps

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Special thanks to Dr. Sarah Battersby for all of the insight, knowledge and encouragement

Abstract

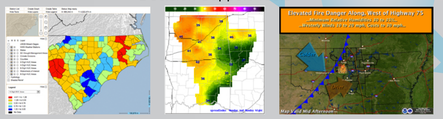
Decision support systems (DSS's) increasingly communicate through information visuals such as maps. When viewing a map, it is often assumed that all the data presented is truthful and accurate. This is never quite the case, however, as maps are just simplified representations of reality. **Cartography faces the challenge of communicating data's reliability in order to enhance decision making.**

Maps + Data + Data reliability = Enhanced Decision Making

Individuals participating in various forms of management seek information to guide their learning, understanding, and decision-making. Web based decision support tools facilitate this, but often fail to provide any measure of the presented data's reliability. Therefore, decision support systems (D'S) put managers in contact with data of varying degrees of reliability, as uncertainty is unavoidable and inherent in information.

Decision Makers

Decision Support Tools



Aid in decision making

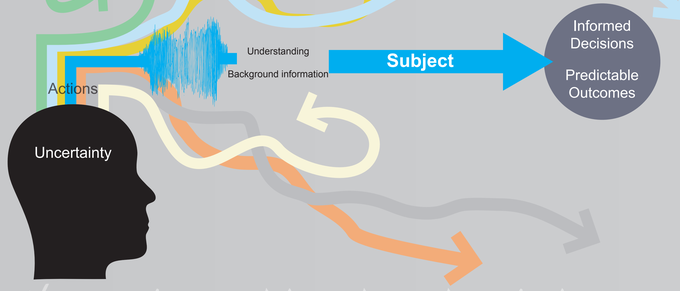
BUT... Experience difficulty communicating data uncertainties

Decisions

Uncertainties

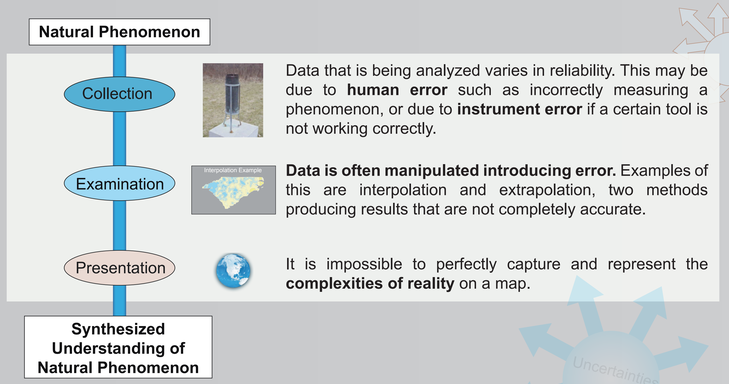
What is uncertainty?

Uncertainty occurs when you lack a complete understanding and background information about a subject. It makes it difficult to make informed decisions and judge outcomes.



How does it arise in data

As data is collected, examined, and presented, uncertainties compound.



Data that is being analyzed varies in reliability. This may be due to **human error** such as incorrectly measuring a phenomenon, or due to **instrument error** if a certain tool is not working correctly.

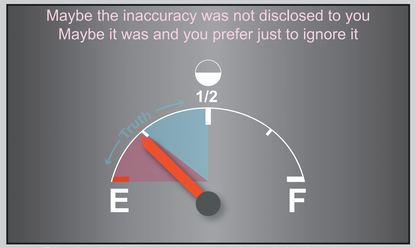
Data is often manipulated introducing error. Examples of this are interpolation and extrapolation, two methods producing results that are not completely accurate.

It is impossible to perfectly capture and represent the **complexities of reality** on a map.

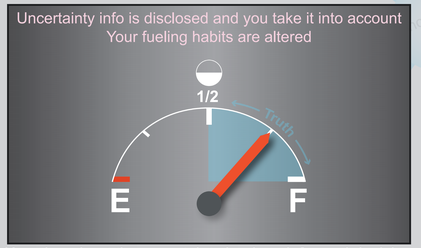
Why communicate it?

Information always carries some degree of uncertainty. Therefore, if a decision support systems uses a map to communicate, should it not convey the data's reliability to allow for optimal decisions?

An example: You borrow a car with an inaccurate gas gauge. Its true to within a quarter tank of the needle.



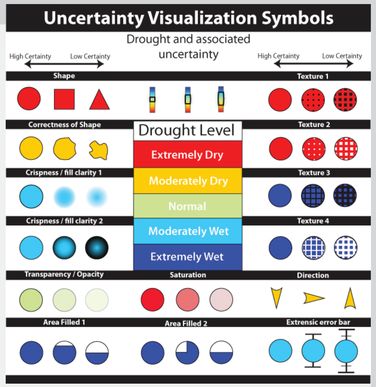
Dipping below a quarter tank is risky business. Are you keen on running out of gas?



Knowing about the uncertainty leads to informed decisions and helps you avoid running out of gas.

The work being done

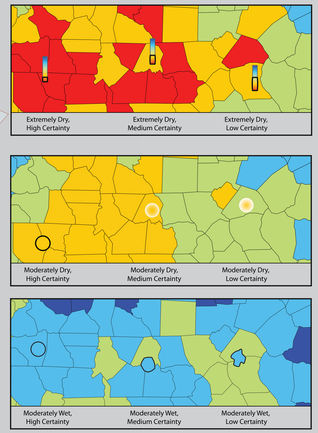
Currently, **there is no clear conclusion as to how data quality should be depicted**, and this has been recognized as an important challenge to the visualization field (Wittenbrink et al. 1996). There have been numerous suggestions, but **there has been little testing of these proposed methods** (MacEachren 1997). In order to address this need, fifteen sets of symbols have been designed that aim to communicate a data value as well as its corresponding degree of certainty. These symbols were developed based upon ideas posed in the cartographic literature from the authors MacEachren, Schweizer and Goodchild, Leitner and Buttenfield, Drecki, Wittenbrink, Pang, and Lodha, Deitrick and Edsall, and Cliburn et al..



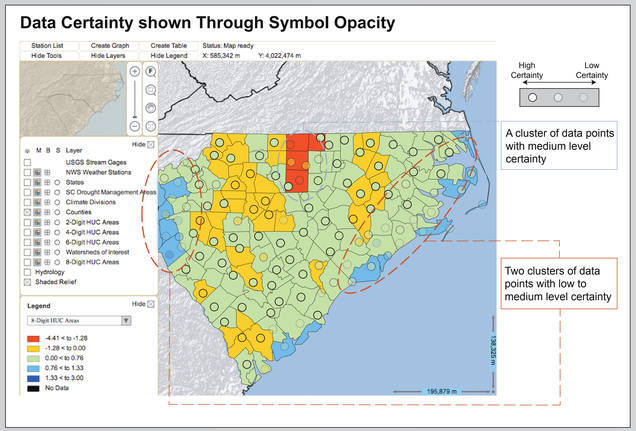
Symbols fall into two categories

Intrinsic symbols modify a characteristic of the symbol such as opacity, shape, or texture to portray uncertainty, while extrinsic symbols use additional geometry.

A visual example:

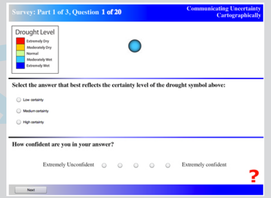


Symbols will be placed at point locations



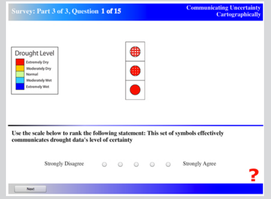
Surveys being conducted

Two separate human-subject surveys are being conducted evaluating symbol performance. The first is a comprehensive evaluation of all fifteen sets of symbols. It examines:



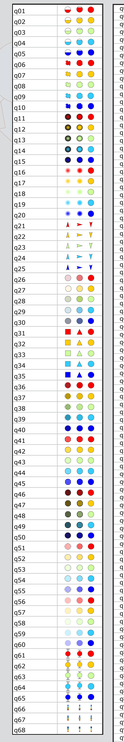
Intuitive abilities of symbols

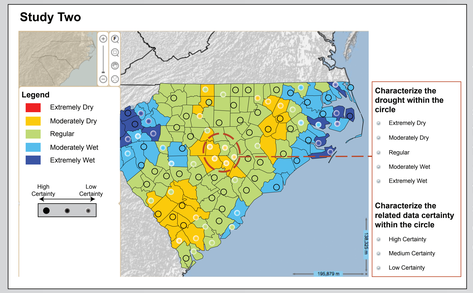
Intuitive abilities of symbol sets



Feedback regarding participant's perceived effectiveness of the symbols

All of the symbol sets (left) and symbols (right) that appeared in the survey





The second survey will place **the most successful symbol sets** from study one on maps for re-evaluation. Generating results from a testing environment similar to what decision-makers actually experience is desired (Hope and Hunter 2007).

Conclusions

Communicating uncertainty is important, but there is limited knowledge and studies examining comprehensively the best way to do this on a map. The proposed effectiveness testing will provide valuable information to the uncertainty visualization community and allow for better communication with individuals using decision support tools and maps.

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