

Representing Data Uncertainties in Overview Maps

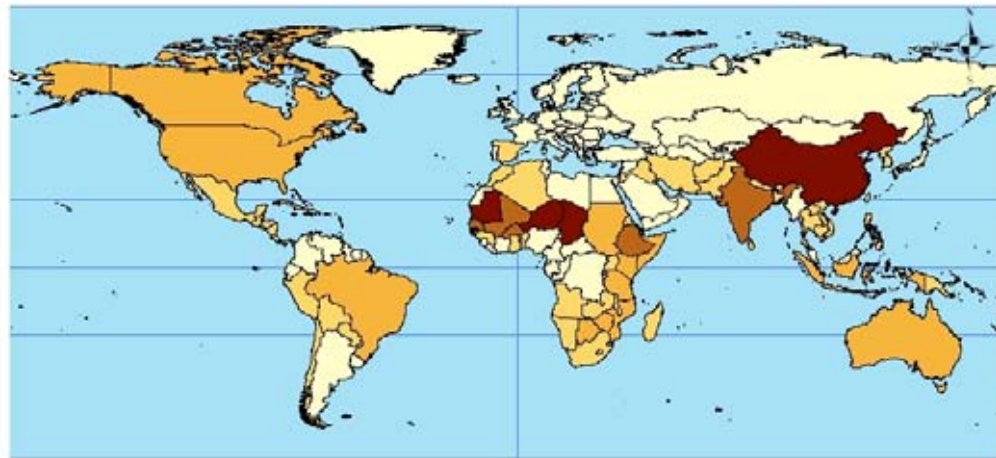
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Organization

- Problem Statement with examples
- Objective of the study
- Literature Review
- Relevant Issues
- Suggested Approaches and Concluding Remarks

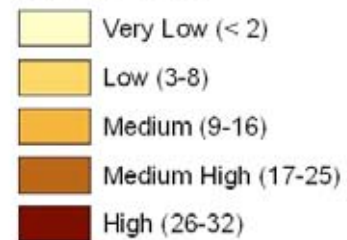
Problem Statement: Example Map 1

Drought Prone Areas - Global Map



Drought Frequency

CREDBE.org

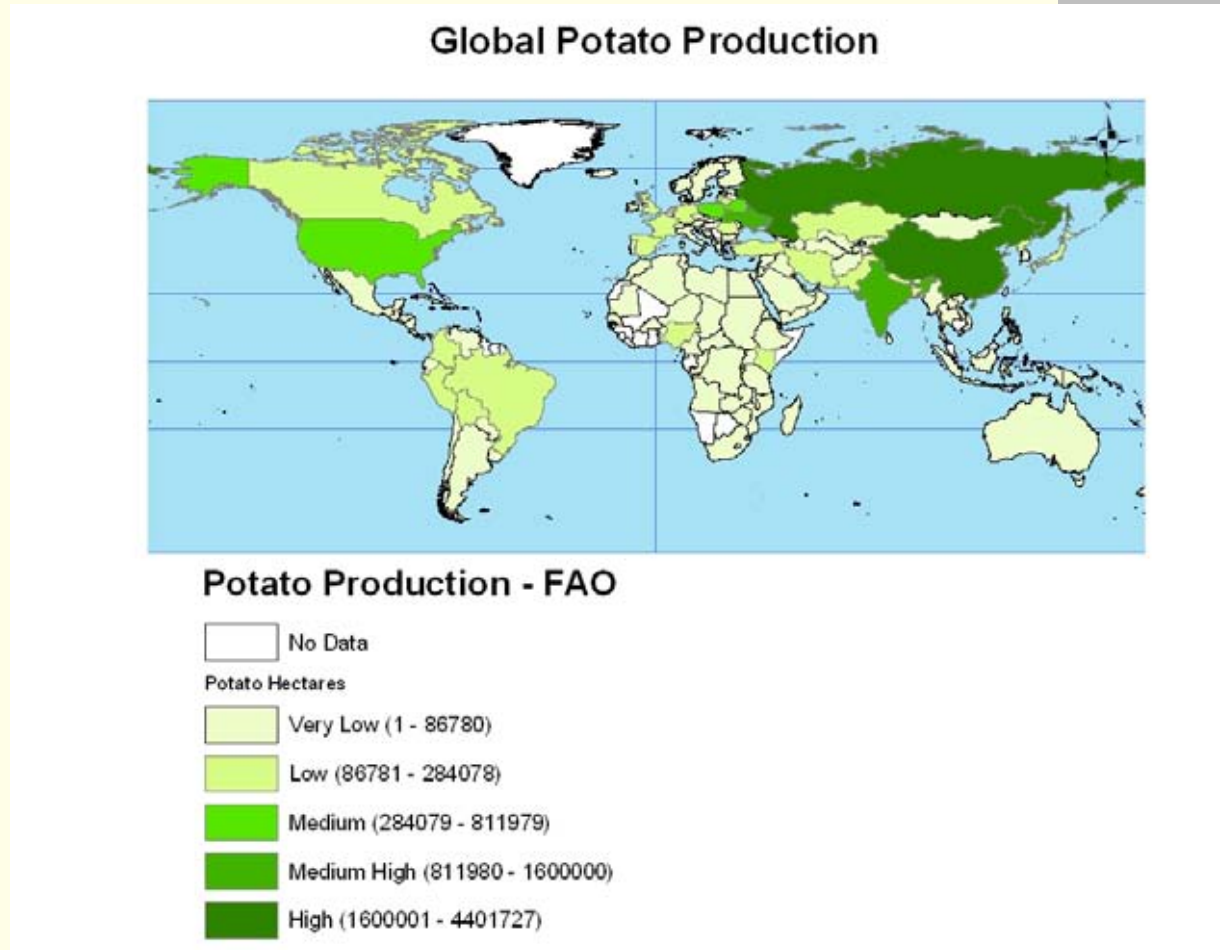


Problem Statement:

Example 1 - Hidden Uncertainties

- **Data completeness:** Not all drought, but only droughts recorded and retrieved by CREDBE
- **Temporal Uncertainty:** Which year droughts were considered, for each country?
- **Spatial Uncertainty:** Was all of China, all of Brazil under drought?

Problem Statement: Example Map 2



Problem Statement:

Example 2: Hidden Uncertainties

- Temporal Uncertainty:

- The year of agricultural census used to assess the total hectares for all the countries, the same?
- If no, how current is the data for each of the country?

- Spatial Uncertainty:

How much does potato production spatial distribution vary within a country area – countries with just one corner of highlands producing most of its total potato!

SIGNIFICANCE:

Why is it important to reveal?

- Agricultural land use change happens at enormous scale and rapid time in African countries. If the data is five years old, it could be practically useless to interpret today.
 - (Late Blight erased all hopes of cultivating potato in Ethiopia)
- Kazakhstan data is part of Russian data until it divided from it.
 - (Leading to less records on Kazak, and not less drought!)

Objective of the study

- To understand different ways of representing temporal and spatial uncertainty as a part of a map.

(Purpose: To improve transparency on quality of data underlying a map without compromising ease of theme interpretation)

Literature Review

- Representing data quality and uncertainty is a huge theme in the world of cartography and geographic information science and there is an enormous amount of publications in this topic.
- The importance is understood and agreed by everybody
- Methods to visualize uncertainty has been discussed in enormous quantities with much technical inclination (like what color, what texture, how much saturation and hue etc.)
- User friendliness, and increase in value in decision making has not been evaluated rigorously across different methods.

Literature Review: Necessity

- In the past there was only exclusive use of precise data or the data was assumed to be precise.
- In recent years, there is more allowance of "soft data", data with uncertainties. (Clarke et.al 1999)
- Uncertainty need not be excised as a flaw, but needs to be managed and accepted as an intrinsic part of complex knowledge (Helen Couclelis, 2003)

Literature Review - Applications

- Disease Risk and Uncertainty (DeCola, 2002):

An incidence grid (blue to red) is combined with a probabilistic confidence grid (controlling the saturation of the hue in each grid) represents the data quantity and quality together.
- Coastal Hazard of Climate Change (Cowell, 2003)
- Datum Level Uncertainty in Historical GIS (Plewe, 2003)

Literature Review: Methods Evaluation

- Leitner et al (2000)

a) In simple decision making processes:

the addition of attribute certainty,

in the form of lighter value, finer texture or higher saturation, improved the correctness of decision making

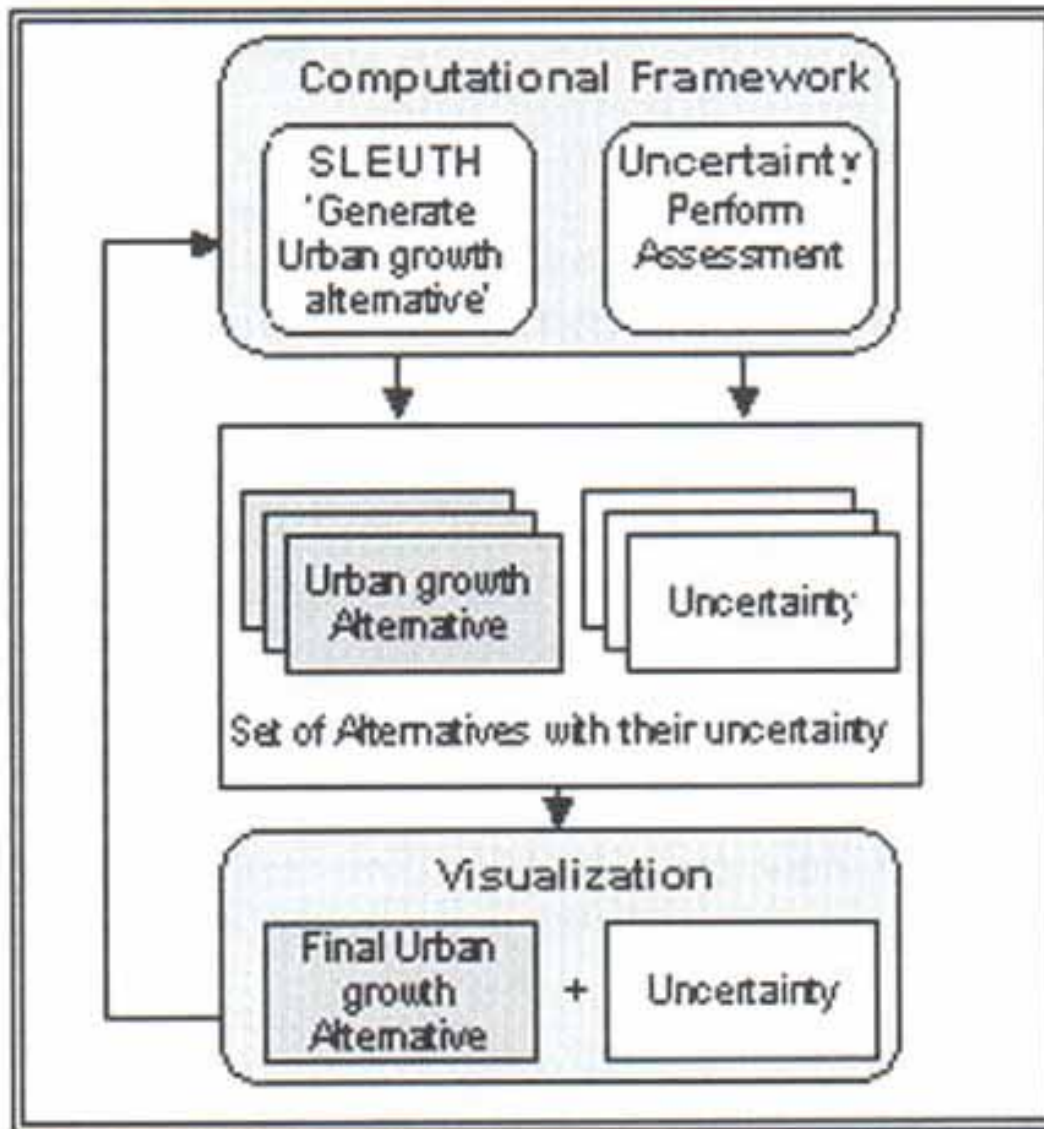
was not perceived as an addition of map detail and hence the response time did not change significantly.

b) Addition of attribute certainty theme did not make much difference in complex decision making processes.

Literature Review: Evaluation of Prior Uncertainty Visualization Methods

- MODEL UNCERTAINTY:
- Aerts et. al (2003) –
 - Visualized uncertainty for an urban growth model
 - did a web survey on the benefits of visualization
 - compared static and toggling methods.
- RESULTS:
 - The model uncertainty visualization introduced more transparency over the process for decision makers.
 - Static comparison was preferred.

Spatial Decision Support System (SDSS)



Issue 1: User friendliness and map complexity

- To represent data uncertainty within a map (as hue variation) in a one attribute thematic map may be acceptable.
- In complex thematic maps with several variables, each with different levels of uncertainties would mean, reaching the threshold of complexity tolerance to human interpretation.

Issue 2: Uncertainties come in all shapes

- Ambiguity is different kind of uncertainty than approximation (lack of accuracy).
- Uncertainty in data/attribute is different from uncertainty in models.

Issue 3: Who cares about uncertainty:

- A lot of journal articles
- A lot of academic studies
- Not many of the real world maps! (none?)
- Do decision makers (users) care?
- In OGC website, the search for the keyword "uncertainty" under "all types of specifications" / "discussion papers" returns zero documents!

Who cares about uncertainty?

- Slocum et al. (2003) did 6 step evaluation:
 - Prototype development
 - Evaluation by domain experts
 - Software revision
 - Evaluation by usability experts
 - Software revision
 - Evaluation by decision makers (users)
- They found out that evaluation by users should have been at the very early stage – step two
- They found out that the users were not comfortable about the idea of uncertainty!

Principle to the new approach of adding data uncertainty in a Map Information Tablet

- Keep it
- Keep it simple
- Keep it separate
- Keep it user oriented/friendly

Potential Approaches:

- Incorporating data uncertainty as an “overview map – thumbnail sized map” at the bottom of a map.
- Incorporating data uncertainty as an “appendix map” in a map collection
- Explicit verbal note on uncertainty boxed along with the map legend.

Concluding Remarks

- It would take real passion for transparency in data quality and dedication to user friendliness to bring it into everyday practice.

Because,

- There is a lot of science that's talked about in this theme, but nobody really implements them in real world!
- Users like hard truths than soft truths.
- A thematic map is already complex enough without any transparency on data quality.

Concluding Remarks - Questions:

- Have any one of you made maps with data uncertainty incorporated in it, for a real world distribution (not academic publication)?
- Does my approach of incorporating uncertainty seem necessary and/or appropriate from your point of view?

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