The impact of user expertise on geographic risk assessment under uncertain conditions

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Robert Roth | reroth@psu.edu
GeoVISTA Center, Department of Geography
Penn State University

agenda

introduction: the overlap of two current trends in GIScience and the research questions

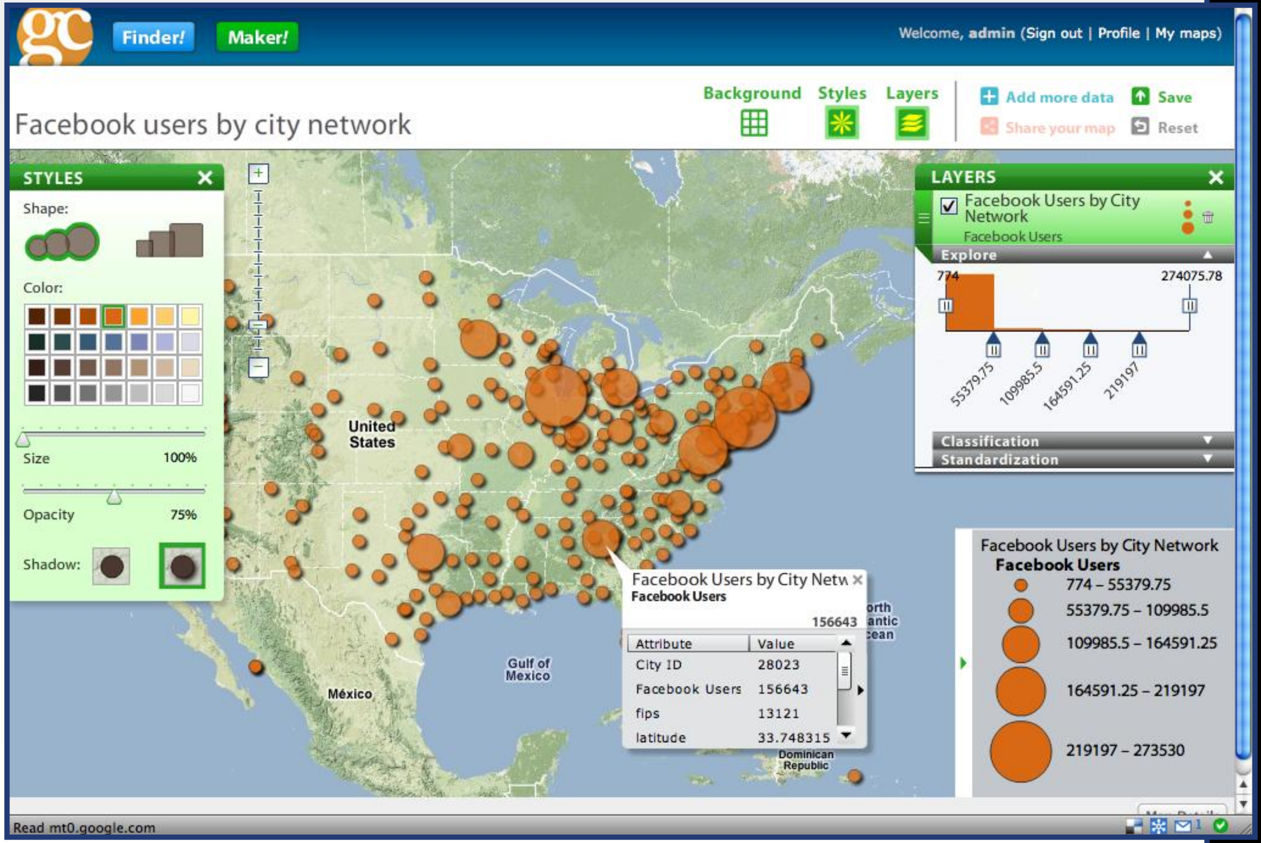
literature review: three important studies on expertise and uncertainty

methodology: an online survey using the case study domain of floodplain mapping

results: the impact of expertise on geographic risk assessment under uncertain conditions

trend #1

the growing availability, affordability, and pervasiveness of geographic information



trend #2

the growing consensus among GIScientists that uncertainty is inherent in all geospatial datasets

“uncertainty is an intrinsic property of knowledge and not just a flaw that needs to be excised”

Couclelis (2003, 166)

hypothesis

novice map users + uncertain geographic information =

potential disaster

research questions

what is the impact of user expertise on:

(1) geographic ***risk assessments*** completed under uncertain conditions,

(2) the users' ***perceived assessment difficulty*** in using these representations, and

(3) the users' ***assessment confidence*** when using these representations.

literature review

Evans (1997)

DYNAMIC DISPLAY OF SPATIAL DATA-RELIABILITY: DOES IT BENEFIT THE MAP USER?

BEVERLEY J. EVANS*
RD#1, Box 339, New Castle, PA 16101

(Received 2 October 1996; accepted 15 December 1996)

Abstract—As users of maps we are dependent upon their veracity, and by extension the reliab
the data they contain. Several research projects have explored possible methods of visually repre
data certainty, a kind of metadata; methods considered include depicting the metadata as a map
separate from the data map, imbedding the metadata into the data map, and creating an interac
vironment allowing simultaneous viewing of both data and metadata. A practical consideration
develop methods for graphic depiction of data reliability, is the reaction to and acceptance of pr
methods by the map user. This research studied how maps containing graphically depicted reliab
formation are used. Potential "usability" of the cartographic display of data reliability is explo
the type of map user (novices versus experts, and males versus females) and the type of m
(assessment of map reliability, confidence in data reliability assessments, and ability to judge t
portion of the areas within the map containing highly reliable data). This study addressed thes
by exploring and analyzing subject response
of reliability. The graphic depiction of relia
hensible by all subjects; novice or expert, ar
liability information, as a composite static c
by the subjects tested. Two other methods
reliability information and an interactive "t
not found to be as efficient or effective as th

Aerts et al. (2003)

Testing Popular Visualization Techniques for Representing Model Uncertainty

Jeroen C.J.H. Aerts, Keith C. Clarke, and Alex D. Keuper

ABSTRACT: Many land allocation issues, such as land-use planning, require input from extensive spatial databases and involve complex decision-making. Spatial decision support systems (SDSS) are designed to make these issues more transparent and to support the design and evaluation of land allocation alternatives. In this paper we analyze techniques for visualizing uncertainty of an
s designed to aid decision-makers in the field of
l framework of an SDSS. Two simple visualization
omparison and toggling—are applied to SLEUTH
nformation and color schemes. In order to evaluate
iques, a web-based survey was developed showing
e usefulness of the two techniques. The web survey
rstand by the participants. Participants in the survey
ision-makers. They acknowledged the usefulness of
poses. They slightly favored the static comparison
niques were applied to an urban growth case study
USA.

Kobus et al. (2001)

Effects of experience and uncertainty during dynamic decision making

David A. Kobus[a,*], Sherry Proctor[a], Steven Holste[b]

[a] Pacific Science & Engineering Group, Inc., 6310 Greenwich Drive #200, San Diego, CA 92122, USA
[b] Space and Warfare Systems Command, San Diego, CA, USA

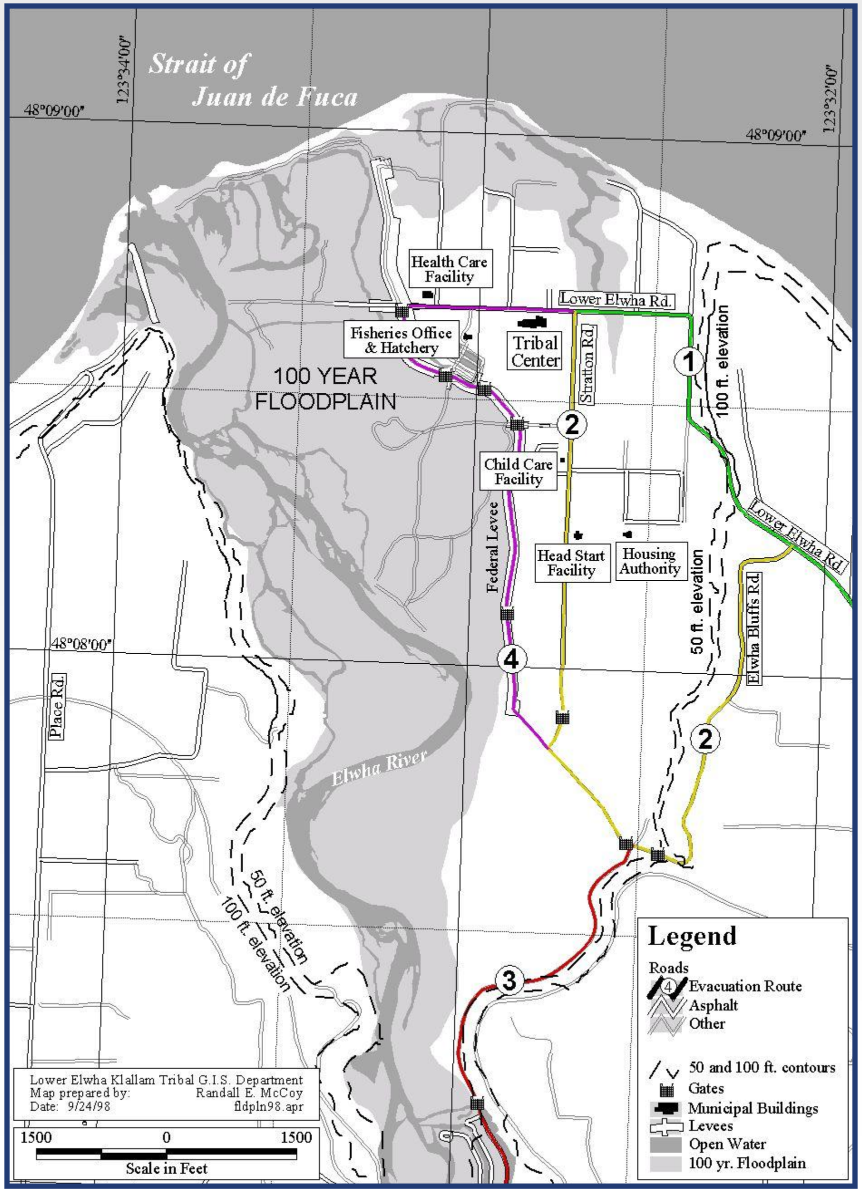
Received 11 January 2001; accepted 9 March 2001

Abstract

The decision response times in a dynamic tactical scenario in which participants interacted with a virtual command-post environment was investigated. Fifty-two Marines with varying amounts of command-post experience assessed the situation as it developed, determined tactical leverage points, formed a plan of action, and submitted battle orders. Two scenarios were studied—each differed in the level of certainty in the information provided. The tactical decision process was modeled and analyzed in the following sequential, cognitive stages: situation assessment, course of action selection, course of action execution. Results show that the time required to assess the situation was significantly longer ($p<0.05$), for the high-experience group than the low-experience group. However, once the assessment was complete, the selection of a course of action (COA) was significantly faster for the high-experience group than the low-experience group. In addition, COA selection under conditions of low certainty was significantly longer than under conditions of high certainty. Time required for COA execution indicated a significant main effect of experience ($p<0.05$), a main effect of task certainty approaching statistical significance ($p=0.067$), and a statistically significant interaction ($p<0.05$). These results indicate that the time needed to execute the COA, once determined, is significantly less for the highly experienced individuals under conditions of low certainty. However, under the conditions of high certainty, no statistically significant time differences were found based upon the experience level. The high-experience group was significantly more accurate than the low-experience group for developing an appropriate COA.

online survey

- a digital survey was developed in Flash and posted online
- used the case study domain of floodplain mapping
- a link to the survey was sent to UW-Madison graduate students and faculty studying either fluvial geomorphology or GIScience as well as private, state, and federal professionals in floodplain mapping and GIScience
- survey sent to 135 potential participants and was completed by 56 people (response rate of 41.5%).

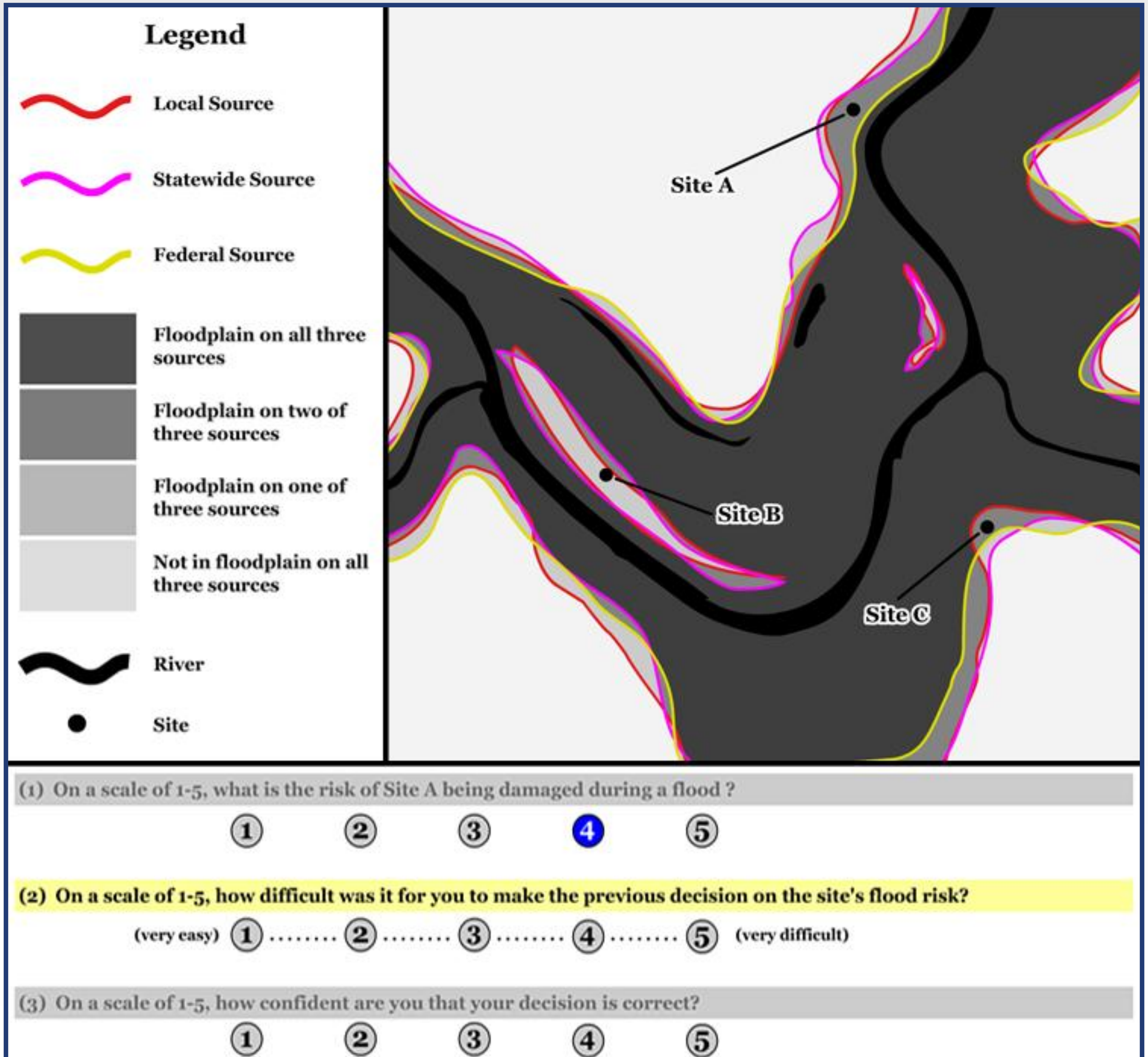


background survey

	Expertise Category	Expert	Intermediate	Novice
domain	Education/Training	26	n/a	30
	Work Experience	21	n/a	35
	Self-Reporting	10	34	12
map use	Education/Training	47	n/a	9
	Work Experience	42	n/a	14
	Self-Reporting	40	14	2

Table 1: Survey participation between experts and novices. This study adopted three definitions of expertise (education/training, work experience, and self-reporting) and identified two different realms of relevant expertise (domain and map use).

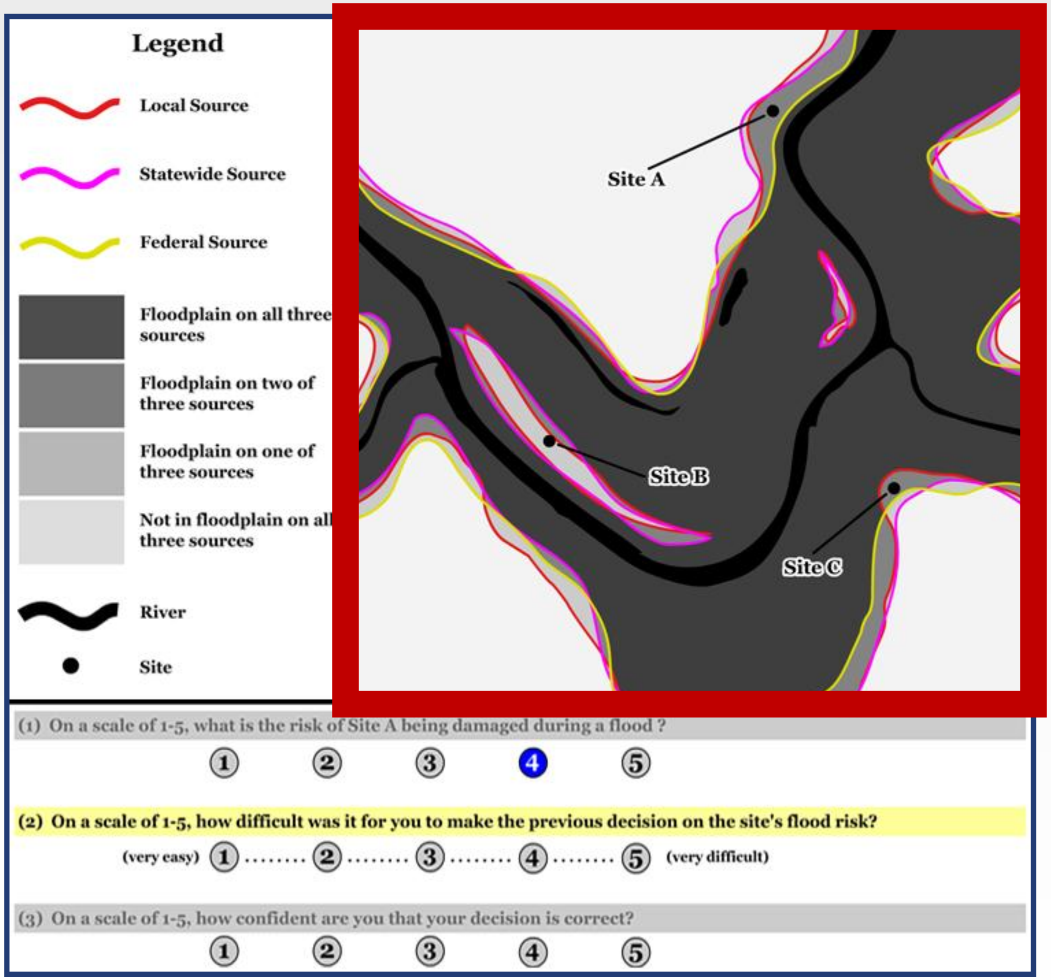
methodology



map component

the map displayed:

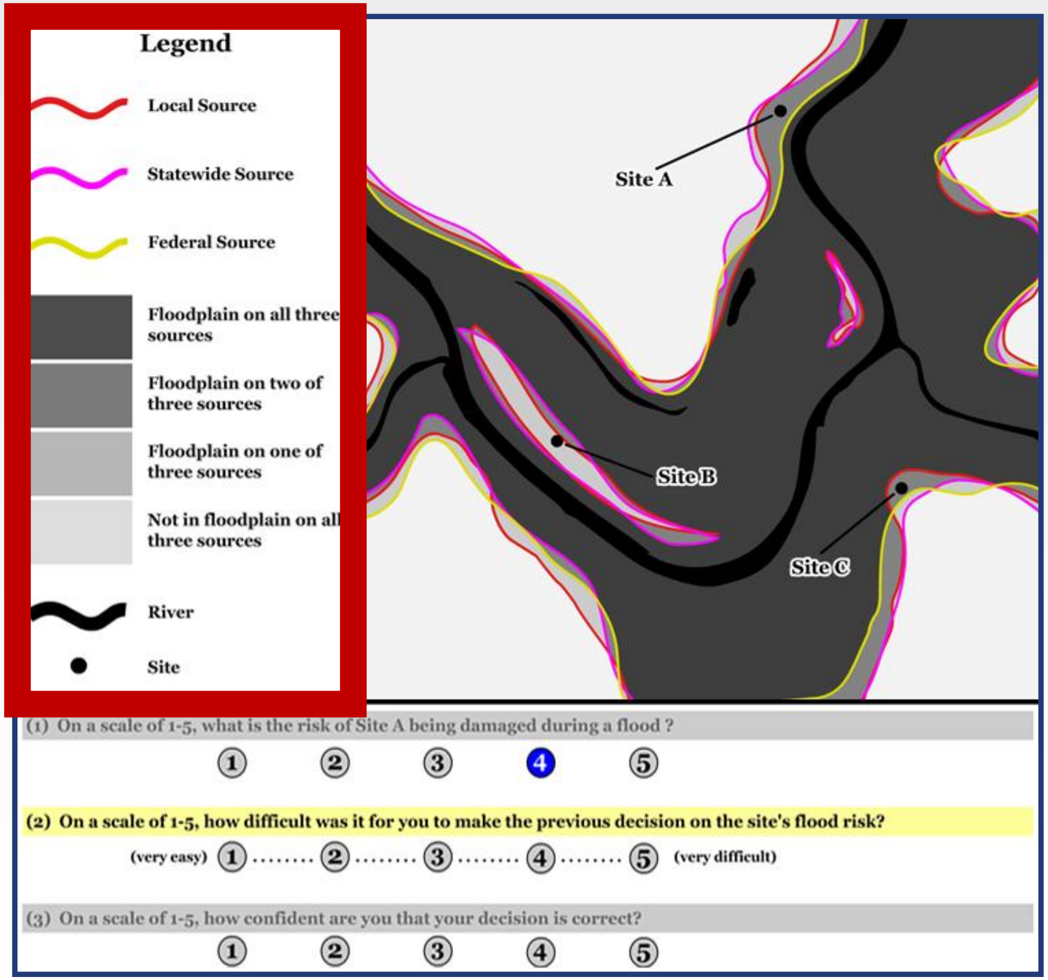
- a river and several tributaries
- three artificial floodplain delineations, each exhibiting a different degree of certainty
- one of three sites of varying risk
- the overlap of the delineations in grey scale



legend component

the legend described:

- the certainty of each line in a given category of uncertainty
- the grey scale symbolization for data agreement
- the river and site symbology



uncertainty categories

Uncertainty Category	*Definition*	*Variation #1*	*Variation #2*	*Variation #3*
Credibility	reliability of the information source	federal source	statewide source	local source
Currency	time span from occurrence through information collection/processing to use	data collected in 2005	data collected in 1995	data collected in 1985
Precision/ Resolution	exactness of measurement/estimate	high detail	intermediate detail	low detail
Subjectivity	the extent of human interpretation/judgment	floodplain defined by a simulated discharge level	floodplain defined by the historical record	floodplain defined by innermost terrace

Table 2: The four uncertainty categories used in the survey, their definitions according to MacEachren et al. (2005), and a description of the three variants for each category as used in the legend component of the survey.

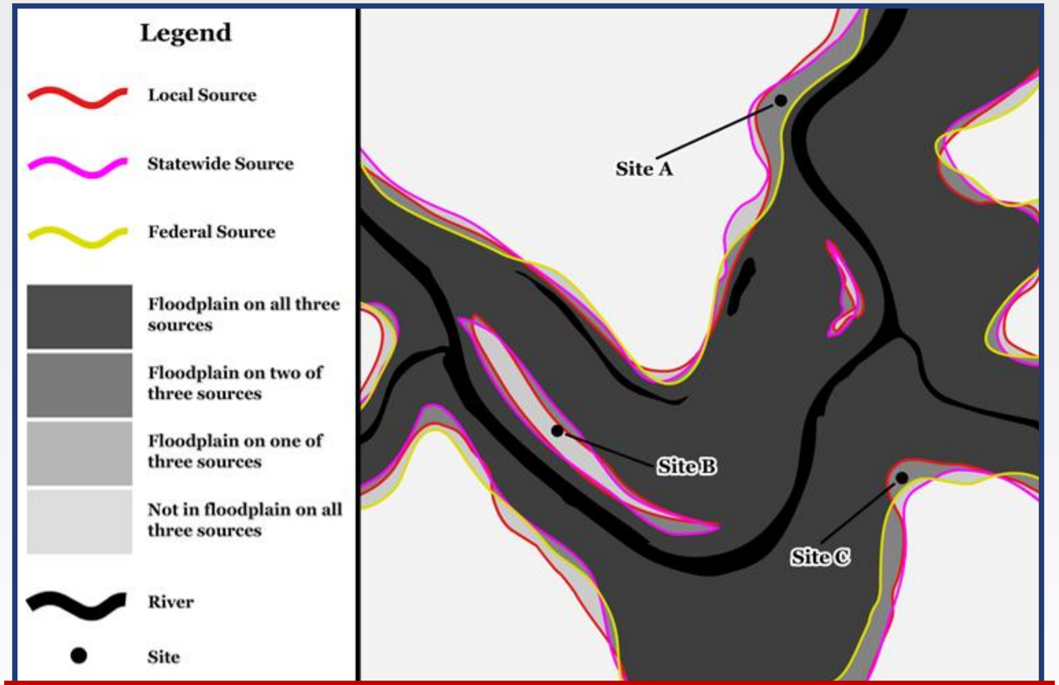
question component

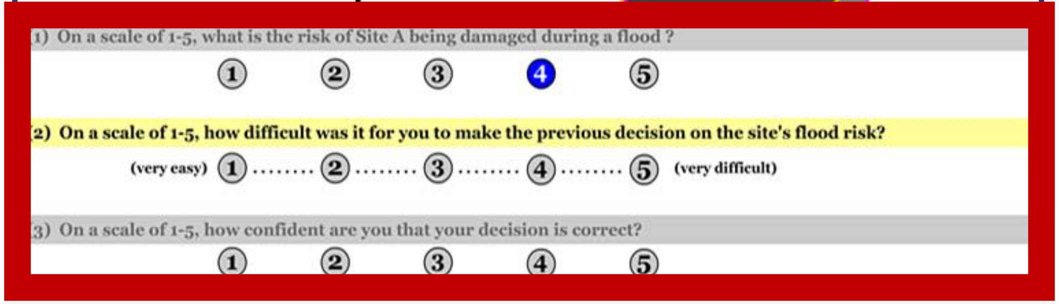
discrete visual analog scales (DVAS)
for the three measured variables:

(1) risk assessment
'1'=safely located
'5'=insecurely located

(2) perceived assessment difficulty
'1'=very easy
'5'=very difficult

(3) assessment confidence
'1'=low confidence
'5'=high confidence





statistical analysis

applied for:

*each category of expertise

*all sites pooled together and each site individually

nonparametric testing:

Mann-Whitney *U* - normal approximation

Kruskal-Wallis *H* - chi-square approximation

null hypothesis = no difference between/among groupings

risk assessment

	Category	Site-A		Site-B		Site-C		All Sites	
		z/X^2	p-value	z/X^2	p-value	z/X^2	p-value	z/X^2	p-value
domain	Education/Training	11.1860	***0.0000***	1.7282	0.0894	0.5582	0.5767	1.6906	0.0909
domain	Work Experience	2.4096	***0.0160***	1.8676	***0.0182***	0.8593	0.3902	1.9564	0.0504
domain	Self-Reporting (X^2)	10.1220	***0.0063***	8.2244	***0.0164***	1.5298	0.4654	9.2882	***0.0096***
map use	Education/Training	0.8702	0.3842	0.7972	0.4253	2.1236	***0.0337***	1.7319	0.0833
map use	Work Experience	0.9869	0.3237	-0.7240	0.4691	1.2286	0.2192	1.0107	0.3122
map use	Self-Reporting (X^2)	0.7314	0.6937	1.3923	0.4985	1.6459	0.4391	0.7194	0.6979

Table 3: Analysis of the variable risk assessment. Overall, experts responded with higher assessments of risk than their novice counterparts. The difference between experts and novices appears especially strong when domain expertise is considered, suggesting that is expertise in the domain at hand, and not in map use and interpretation, that affects a user's ability to correctly assess the risk of a site in the landscape.

risk assessment

	Category	Site-A		Site-B		Site-C		All Sites	
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risk assessment

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perceived assessment difficulty

	Category	Site-A		Site-B		Site-C		All Sites	
		z/X^2	p-value	z/X^2	p-value	z/X^2	p-value	z/X^2	p-value
domain	Education/Training	0.4589	0.6463	1.6538	0.0982	1.6176	0.1057	2.2051	***0.0274***
domain	Work Experience	-1.1170	0.2640	-0.3260	0.7444	-0.3590	0.7196	-0.9851	0.3246
domain	Self-Reporting (X^2)	10.6270	***0.0049***	0.4079	0.8155	5.3699	0.0682	10.9560	***0.0042***
map use	Education/Training	-2.3020	***0.0213***	-1.5020	0.1331	0.3355	0.7372	-2.0016	***0.0453***
map use	Work Experience	-2.1540	***0.0312***	-3.5430	***0.0004***	-0.6750	0.4997	-3.7026	***0.0002***
map use	Self-Reporting (X^2)	3.6201	0.1636	10.6520	***0.0049***	0.8139	0.6657	10.4169	***0.0055***

Table 4: Analysis of the variable perceived assessment difficulty. Overall, experts responded with a lower perceived assessment difficulty than their novice counterparts. The difference between experts and novices appears especially strong when map use expertise is considered, suggesting that is expertise in map use and interpretation, and not in the domain at hand, that affects a user's ability to correct assess the risk of a site in the landscape.

perceived assessment difficulty

	Category	Site-A z/X^2	Site-A p-value	Site-B z/X^2	Site-B p-value	Site-C z/X^2	Site-C p-value	All Sites z/X^2	All Sites p-value
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assessment confidence

	Category	Site-A		Site-B		Site-C		All Sites	
		z/X^2	p-value	z/X^2	p-value	z/X^2	p-value	z/X^2	p-value
domain	Education/Training	2.1138	***0.0345***	-0.8590	0.3903	1.0336	0.3013	1.3178	0.1876
domain	Work Experience	3.5032	***0.0005***	0.4632	0.6432	2.2520	***0.0243***	3.5959	***0.0003***
domain	Self-Reporting (X^2)	17.7920	***0.0001***	4.9002	0.0863	12.4640	***0.0020***	30.3764	***0.0001***
map use	Education/Training	2.7230	***0.0065***	2.8352	***0.0046***	1.8612	0.0627	4.3968	***0.0000***
map use	Work Experience	2.9298	***0.0034***	2.6536	***0.0080***	1.9226	***0.0545***	4.4029	***0.0000***
map use	Self-Reporting (X^2)	6.0243	***0.0492***	6.5678	***0.0375***	4.2550	0.1191	16.2600	***0.0003***

Table 5: Analysis of the variable assessment confidence. Overall, experts felt more confident in their risk assessments than their novice counterparts. This pattern appears to hold up for both domain and map use expertise.

assessment confidence

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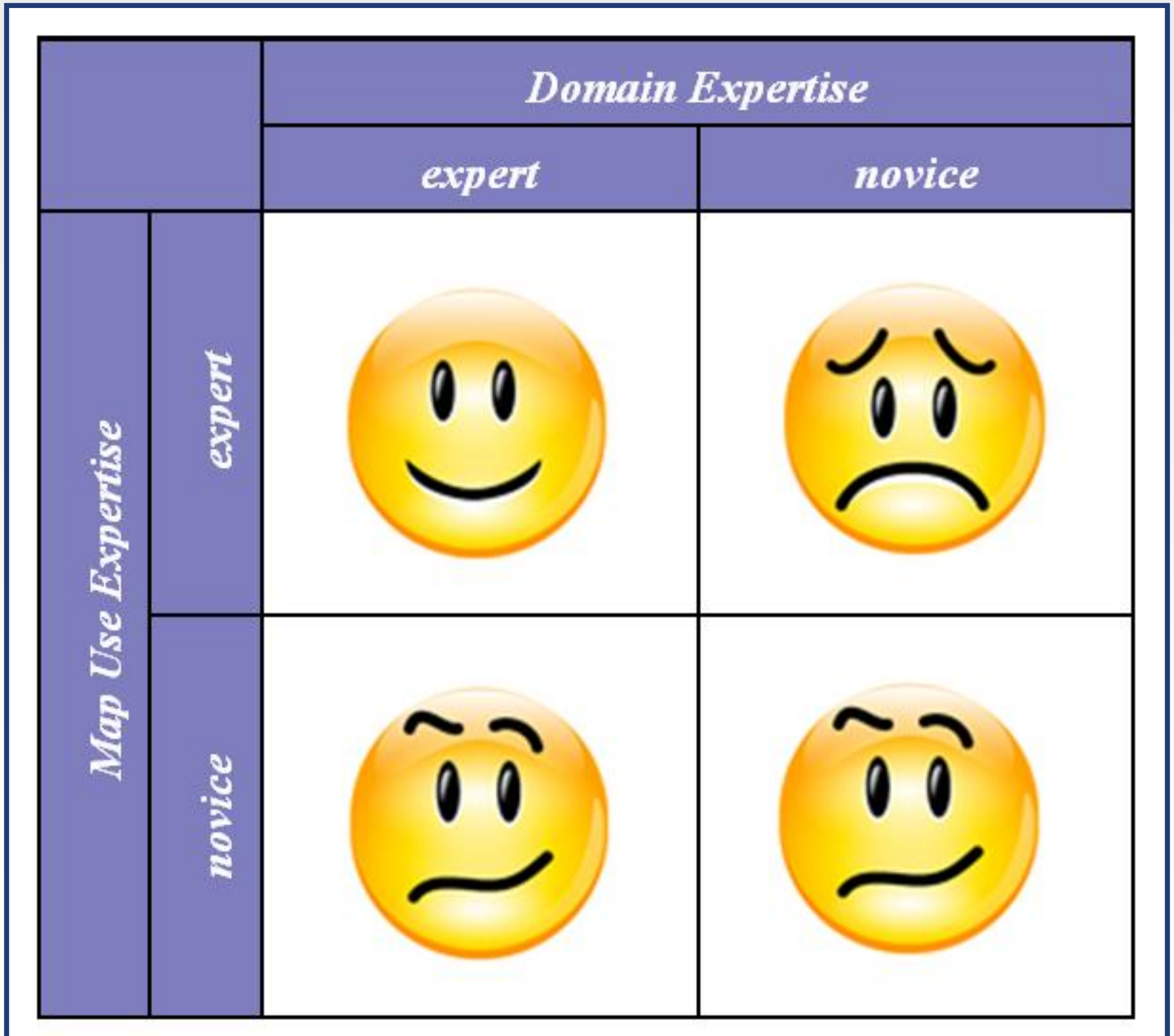
implications of findings



questions?

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thanks! ~rob