Communicating Uncertainty between Risk Assessors and Risk Managers

Sandrine Blanchemanche

Research Context

- HolyRisk Project (2009-2013), France-USA
- Directors: S. Blanchemanche
  & A. Rona-Tas (UC, San Diego)
- Partners
  - Jifsan/Cfsan: E. Calvey, J. Ruzante, S. Watters
  - 3 Computer Sciences Teams
- US / EU Comparison
  - What are the « practices » of sciences?
  - What consequences Uncertainty and Precaution have on Risk Management Decision?

Outline

- Introduction
- Questions/Objectives
- Method
- Uncertainty explicitely expressed in risk assessment reports
- Communication of the language of science
- Conclusion

Introduction

- Scientific knowledge became one of the most important prerequisites for making regulatory decisions.
- As scientific knowledge is never complete, risk assessors are expected to present policy makers with not just what is known but also what is uncertain about a particular risk.
- For policy decisions the nature and level of the incompleteness of the evidence is of great importance and policy action will always be influenced not just by what seems firmly established but also by what is considered uncertain.

- FAO General Principle of food safety risk management : “Risk management decisions **should take into account the uncertainty** in the output of the risk assessment. The risk estimate should, wherever possible, include a numerical expression of uncertainty, and this must be conveyed to risk managers in a readily understandable form so that the full implications of the range of uncertainty can be included in decision-making.

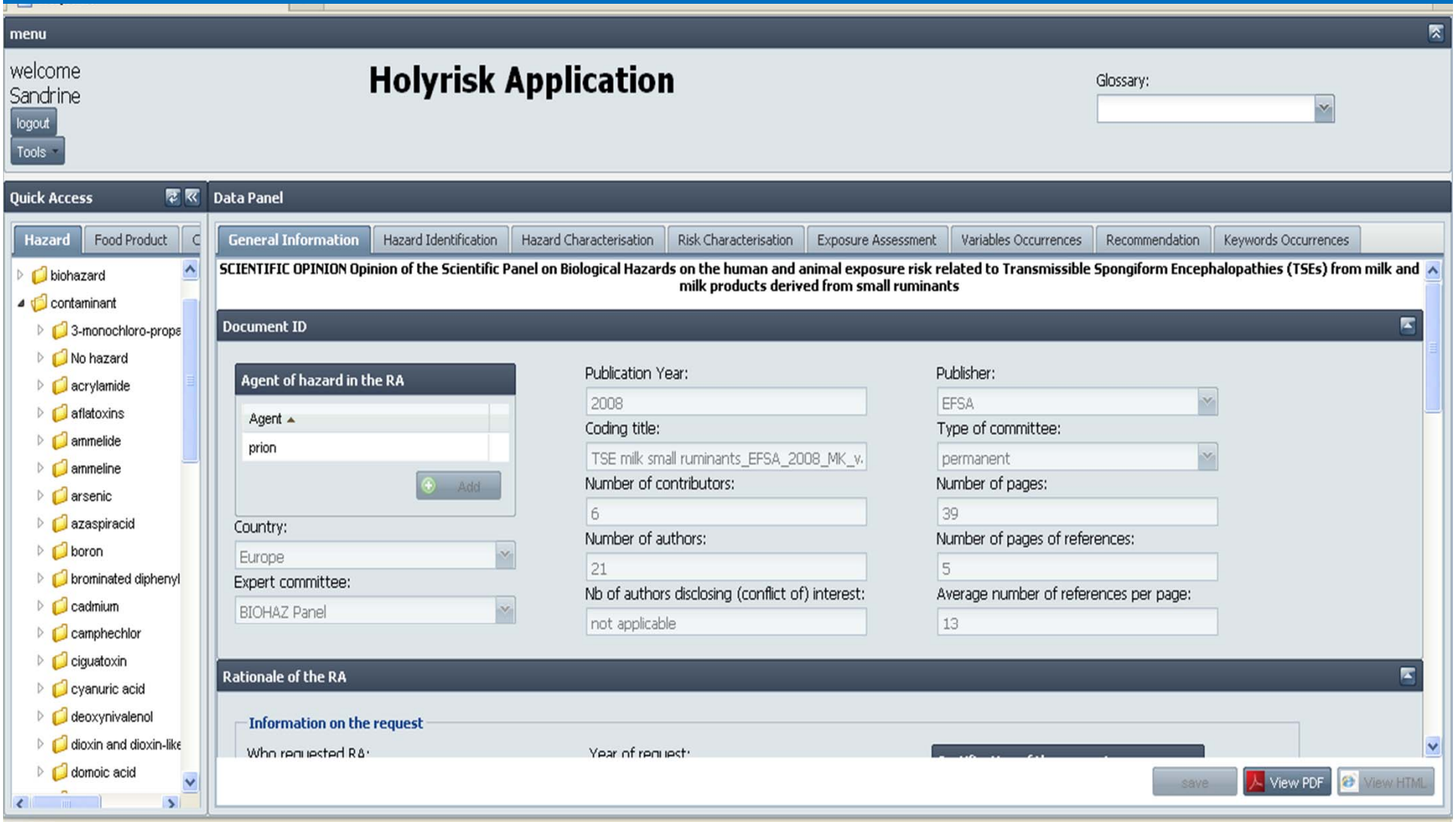
  For example, if the risk estimate is **highly uncertain** the risk management decision might be **more conservative.**”

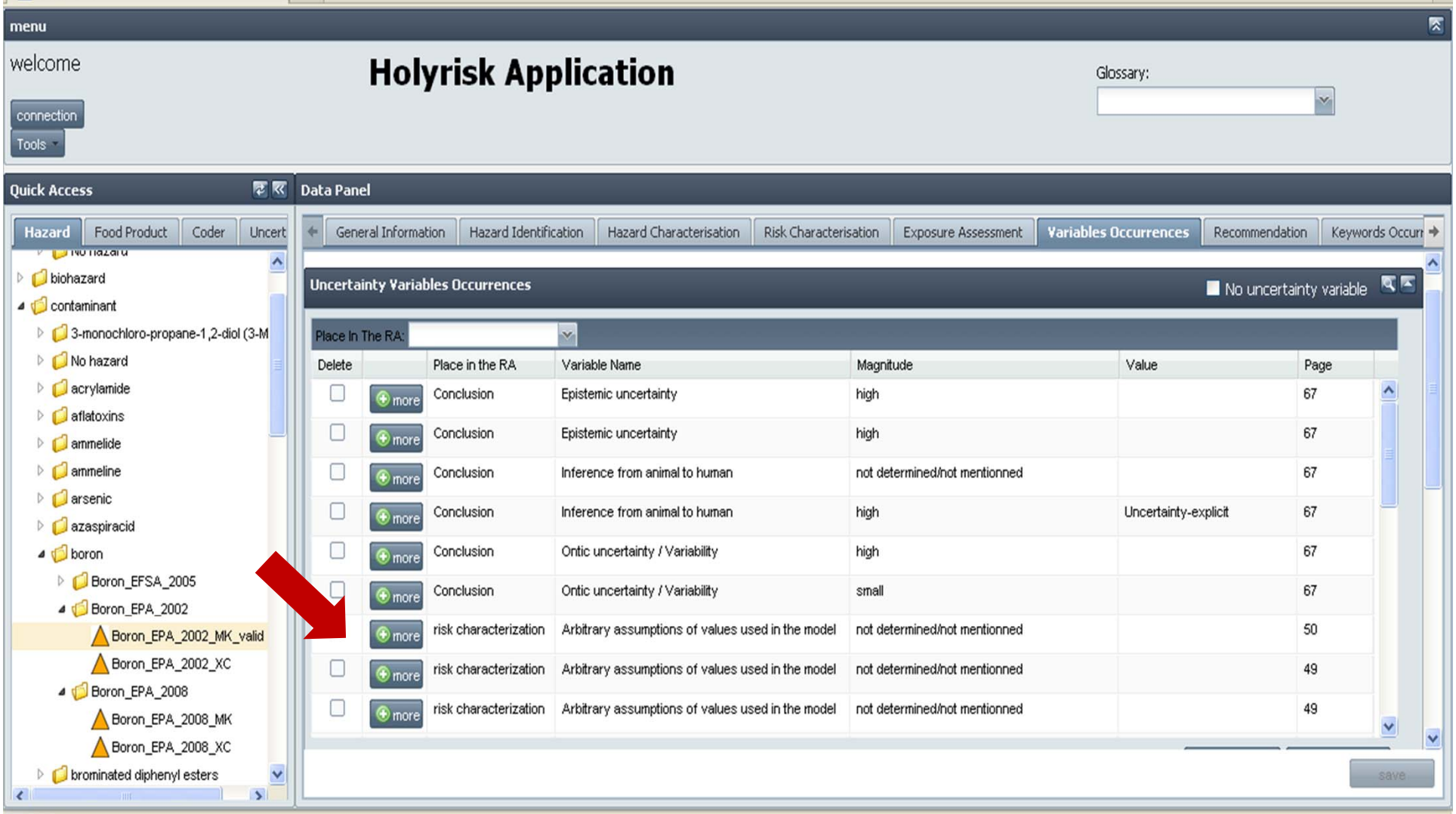
Questions/objectives

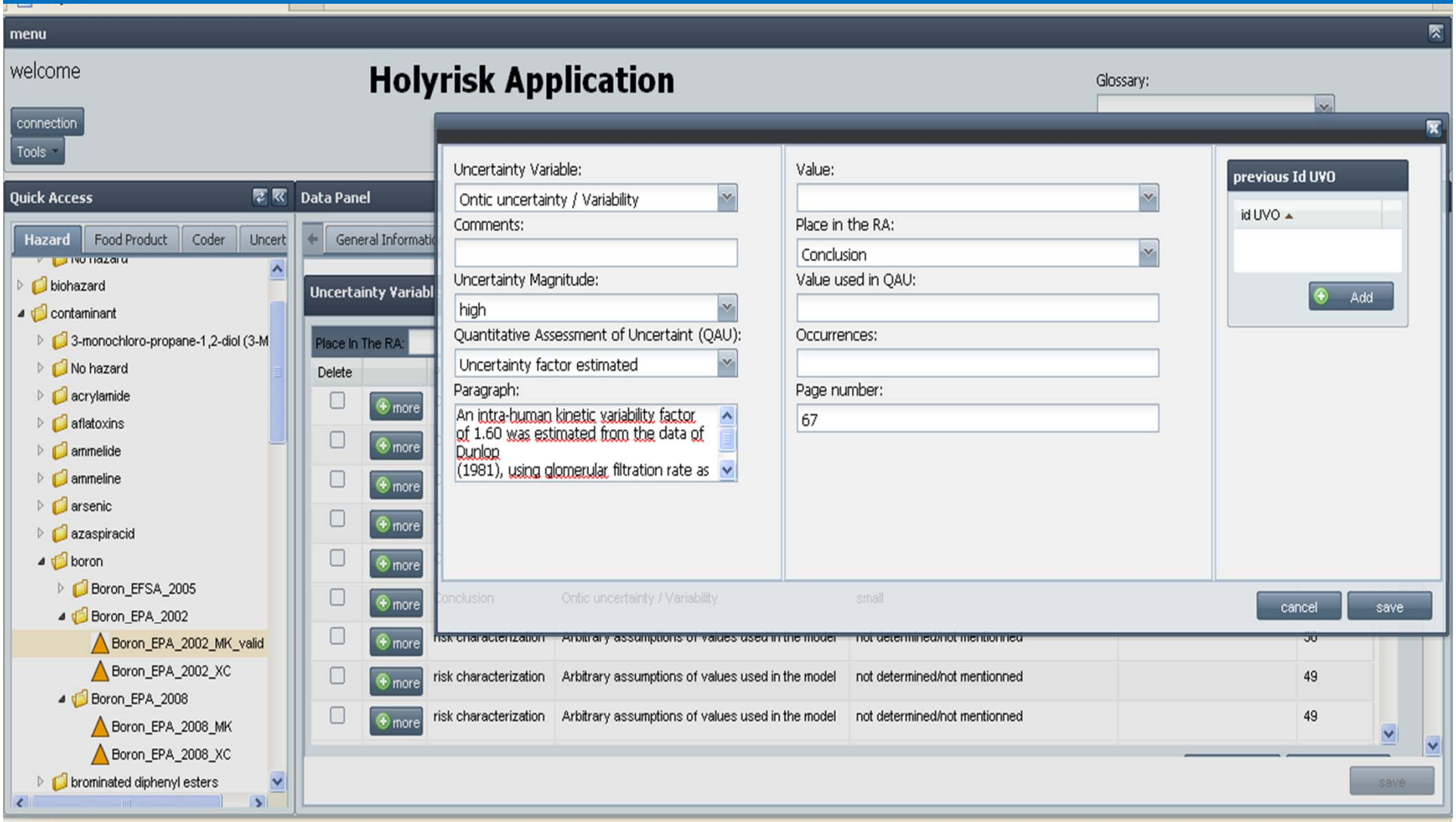
- What uncertainties are expressed in risk assessments? How are they expressed?
  - ➡ Uncertainty explicitly expressed
- What kind of language is used in risk assessment
  - ➡ Language of science: Non formalized language used which may modify the understanding of the statement by the readers (Risk Managers)

Method

- Empirical analysis of Food Risk Assessments Reports in the US and Europe (BioHazards and Contaminants) and the follow up Risk Management
- Construction of a Typology of Uncertainty (28 variables) and a Typology of Judgment (5 variables)
- Double-coding of the documents through the typologies, storage in the HolyRisk Database


menu
welcome
Sandrine
logout
Tools
Holyrisk Application
Glossary:
Quick Access
Data Panel
Hazard
Food Product
biohazard
contaminant
3-monochloro-propa
No hazard
acrylamide
aflatoxins
ammelide
ammeline
arsenic
azaspiracid
boron
brominated diphenyl
cadmium
camphechlor
ciguatoxin
cyanuric acid
deoxynivalenol
dioxin and dioxin-like
domoic acid
General Information
Hazard Identification
Hazard Characterisation
Risk Characterisation
Exposure Assessment
Variables Occurrences
Recommendation
Keywords Occurrences
SCIENTIFIC OPINION Opinion of the Scientific Panel on Biological Hazards on the human and animal exposure risk related to Transmissible Spongiform Encephalopathies (TSEs) from milk and milk products derived from small ruminants
Document ID
Agent of hazard in the RA
Agent
prion
Add
Country:
Europe
Expert committee:
BIOHAZ Panel
Publication Year:
2008
Coding title:
TSE milk small ruminants_EFSA_2008_MK_v.
Number of contributors:
6
Number of authors:
21
Nb of authors disclosing (conflict of) interest:
not applicable
Publisher:
EFSA
Type of committee:
permanent
Number of pages:
39
Number of pages of references:
5
Average number of references per page:
13
Rationale of the RA
Information on the request
Who requested RA:
Year of request:
save
View PDF
View HTML


menu
welcome
Holyrisk Application
connection
Tools
Glossary:
Quick Access
Data Panel
Hazard
Food Product
Coder
Uncert
biohazard
contaminant
3-monochloro-propane-1,2-diol (3-M
No hazard
acrylamide
aflatoxins
ammelide
ammeline
arsenic
azaspiracid
boron
Boron_EFSA_2005
Boron_EPA_2002
Boron_EPA_2002_MK_valid
Boron_EPA_2002_XC
Boron_EPA_2008
Boron_EPA_2008_MK
Boron_EPA_2008_XC
brominated diphenyl esters
General Information
Hazard Identification
Hazard Characterisation
Risk Characterisation
Exposure Assessment
Variables Occurrences
Recommendation
Keywords Occurr
Uncertainty Variables Occurrences
No uncertainty variable
Place In The RA:
Delete
Place in the RA
Variable Name
Magnitude
Value
Page
more
Conclusion
Epistemic uncertainty
high
67
Conclusion
Epistemic uncertainty
high
67
Conclusion
Inference from animal to human
not determined/not mentionned
67
Conclusion
Inference from animal to human
high
Uncertainty-explicit
67
Conclusion
Ontic uncertainty / Variability
high
67
Conclusion
Ontic uncertainty / Variability
small
67
risk characterization
Arbitrary assumptions of values used in the model
not determined/not mentionned
50
risk characterization
Arbitrary assumptions of values used in the model
not determined/not mentionned
49
risk characterization
Arbitrary assumptions of values used in the model
not determined/not mentionned
49
save

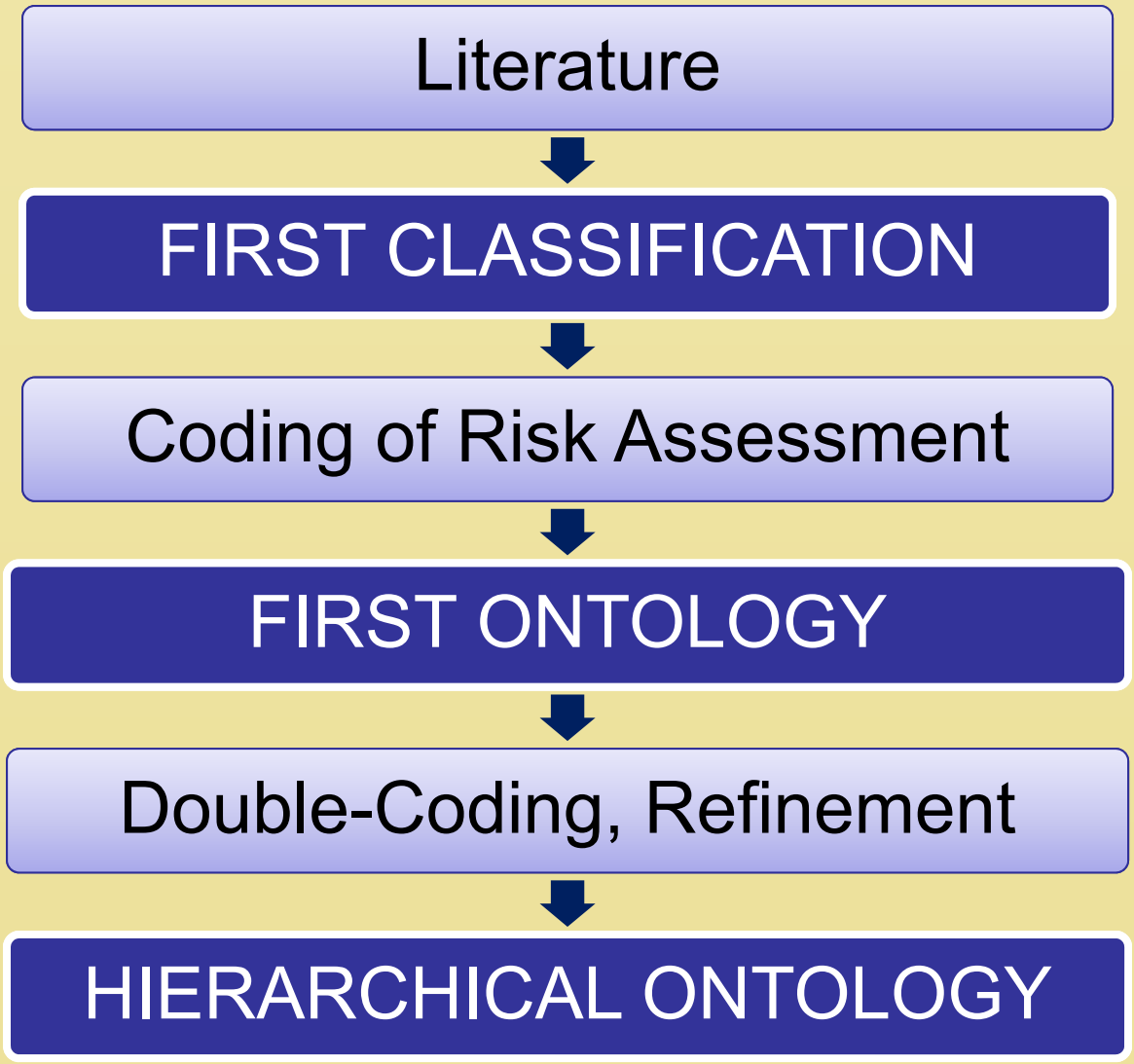

menu
welcome
Holyrisk Application
Glossary:
connection
Tools
Quick Access
Data Panel
Hazard
Food Product
Coder
Uncert
biohazard
contaminant
3-monochloro-propane-1,2-diol (3-M
No hazard
acrylamide
aflatoxins
ammelide
ammeline
arsenic
azaspiracid
boron
Boron_EFSA_2005
Boron_EPA_2002
Boron_EPA_2002_MK_valid
Boron_EPA_2002_XC
Boron_EPA_2008
Boron_EPA_2008_MK
Boron_EPA_2008_XC
brominated diphenyl esters
Uncertainty Variable:
Ontic uncertainty / Variability
Comments:
Uncertainty Magnitude:
high
Quantitative Assessment of Uncertaint (QAU):
Uncertainty factor estimated
Paragraph:
An intra-human kinetic variability factor of 1.60 was estimated from the data of Dunlop
(1981), using glomerular filtration rate as
Value:
Place in the RA:
Conclusion
Value used in QAU:
Occurrences:
Page number:
67
previous Id UVO
id UVO
Add
cancel
save
Place In The RA:
Delete
more
risk characterization
Arbitrary assumptions of values used in the model
not determined/not mentionned
49
save

- The current presentation is based on:
  - The part « Summary » of the Risk Assement Reports because they are considered as the fundamental text of the interaction between the assessors « the writers » and the managers « the readers »
  - 80 coded documents

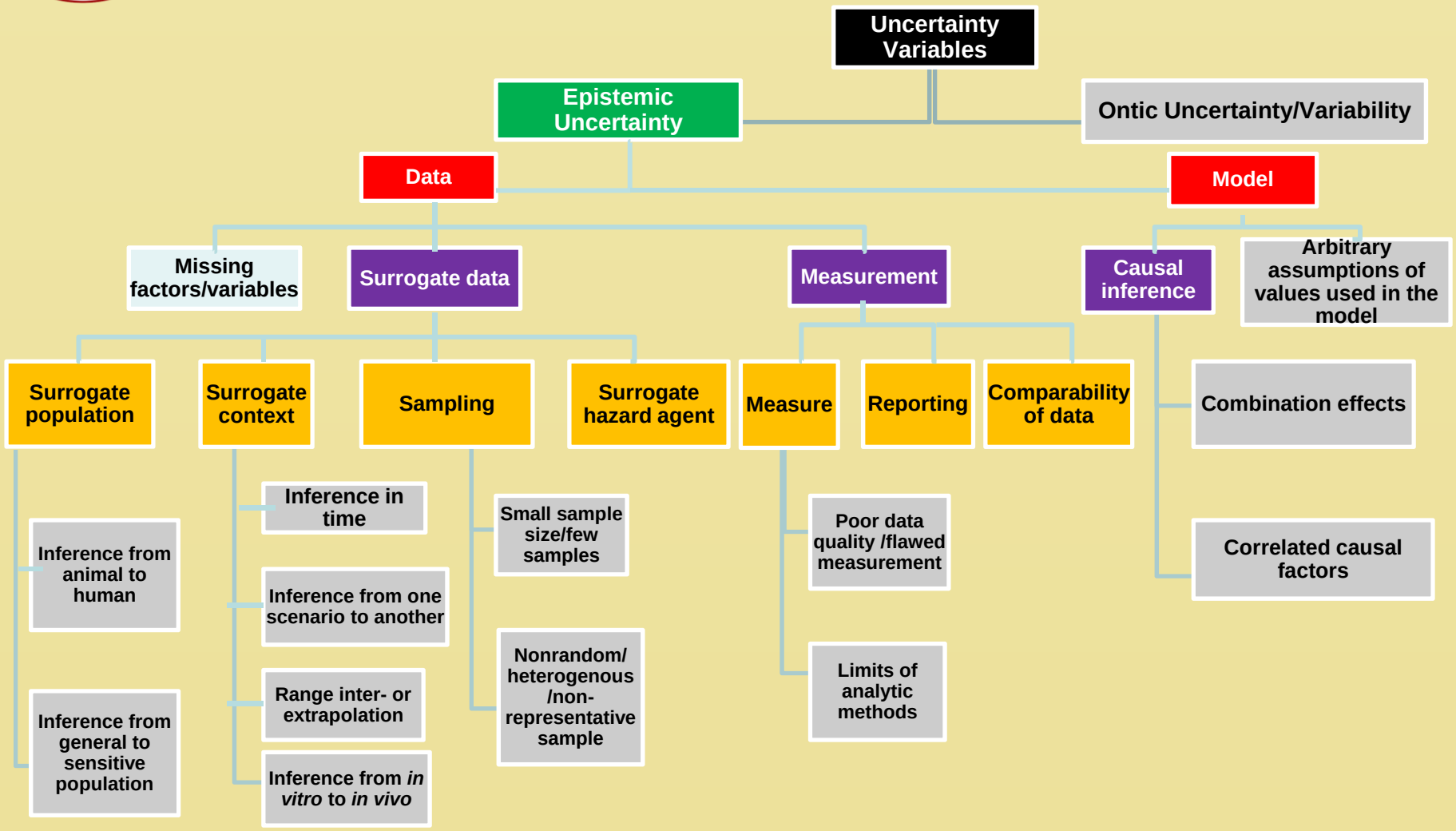
	US	EU	Total
BioHazard	7	29	36
Contaminant	7	37	44
Total	**14**	**66**	**80**

Uncertainty explicitly expressed

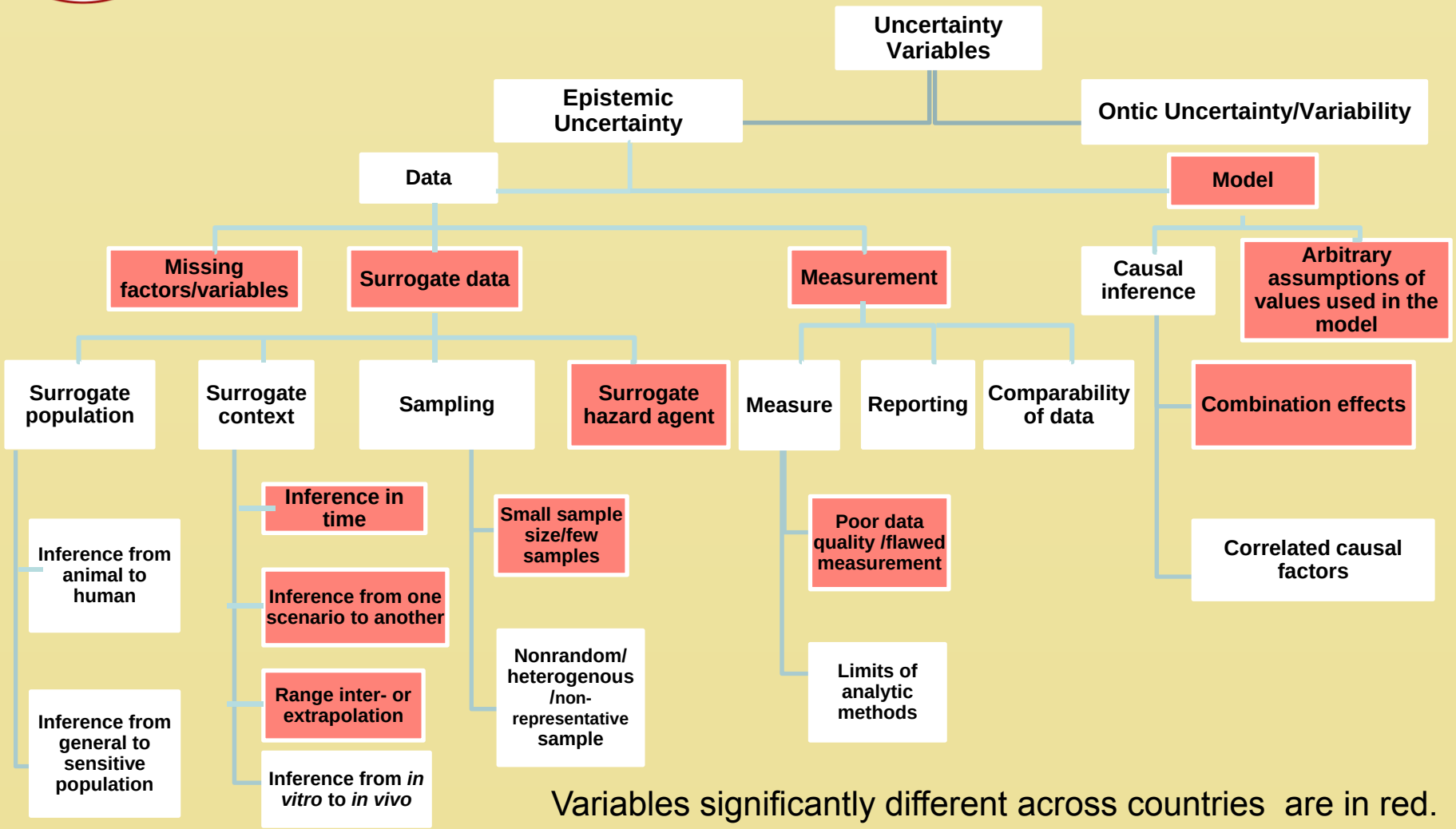
Categorization of Uncertainty



Uncertainty Ontology

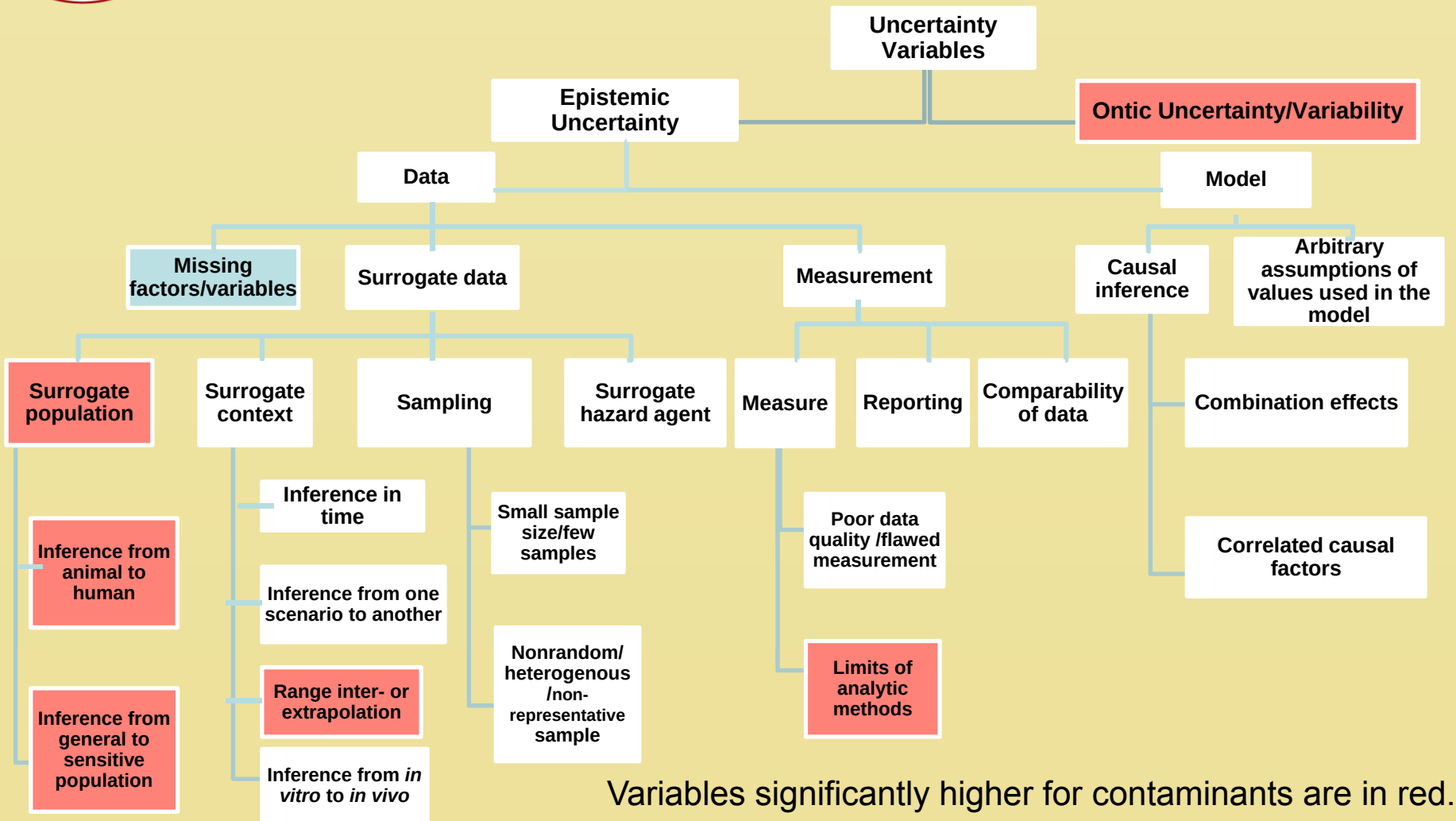


US/EU differences in expressing uncertainty



Variables significantly different across countries are in red.
In all cases the U.S. has the higher value.

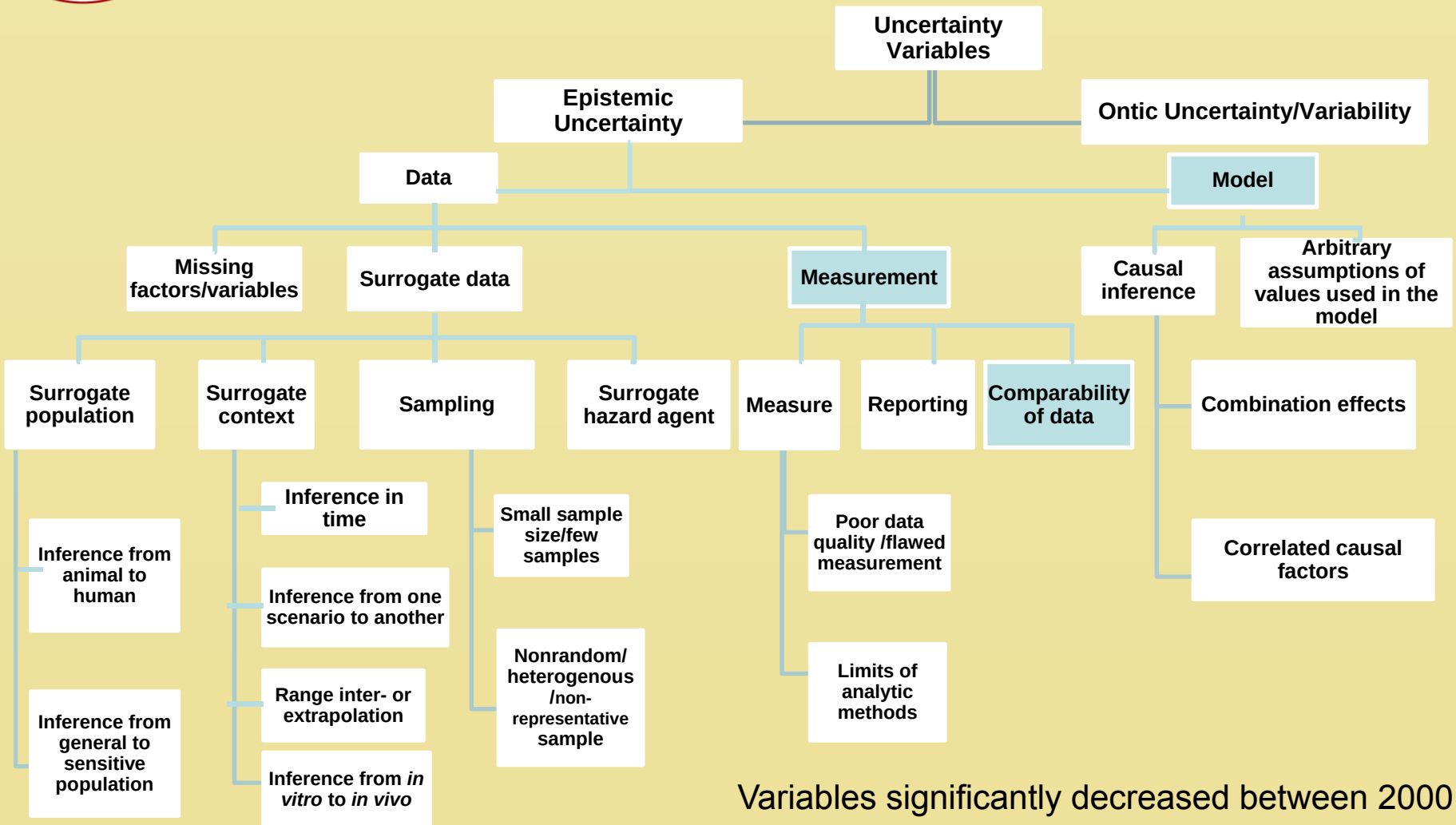
Differences in expressing uncertainty between hazard categories



Variables significantly higher for contaminants are in red.

Those significantly higher for biohazard are in blue.

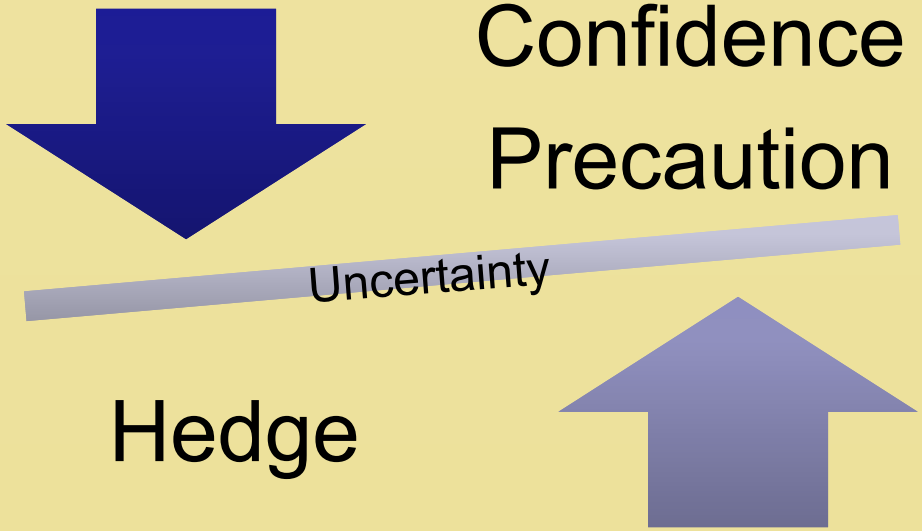
Changes in expressing uncertainty over time (2000-2010)



Variables significantly decreased between 2000 and 2010 are in blue.

Communication of the language of science

- Science has its own language, at the heart of the communication between risk assessors and managers
- We will look at more precisely



Hedge

- Hedges and the way in which they shape knowledge claims in science are well analyzed in Studies of Scientific Communication

  Hyland, 1994, 1998, Myers, 1985

- Definition: Expression of lack of complete commitment to the truth value of an accompanying proposition, regardless if the author is actually committed

  e.g. A ***possible*** expression of this finding ***may be*** that…

  Hyland, 1998, Lewin, 2005

- … Linguistic element whose job is to make things fuzzier

  Lakoff, 1972

- Hedge is a conventional language – expected from the scientific community – used by scientists to anticipate audience reactions **by moderating the degree of certainty** with which they present their knowledge claims

Knorr-Cetina, 1981; Meyer, 1997

- But hedges may cause trouble for the understanding of the scientific statements

Hedge

	US	EU	Total
BioHazard	57 % (4/7)	68% (20/29)	66% (24/36)
Contaminants	86% (6/7)	59% (22/37)	64% (28/44)
Total	**71%** (10/14)	**64%** (42/66)	**65%** (52/80)

% of summaries that include at least one sentence with hedge

Hedges are very common in scientific statements both in the US and EU

Hedge in almost 2/3 of the summaries

Examples

- Given the very low prevalence and levels of E. Coli O157:H7 contamination (…), cross-contamination **may not be a significant factor** in the risk of illness from E. coli O157:H7 in non-intact beef (…)

E. Coli, USDA, 2002

- Compared to dietary exposure, non-dietary exposure to arsenic is **likely to be** of minor importance for the general population in the European Union (EU).
- The arsenic content in cooking water **seems to be** of special importance because it determines whether the arsenic concentrations (…)

Arsenic, EFSA, 2009

Examples, same summary

[…] Compared to dietary exposure, non-dietary exposure to lead **IS LIKELY TO BE** of minor importance for the general population in the European Union (EU). House dust and soil can be an important source of exposure to lead for children. […] The respective MOEs range from 1.2 to 4.2 and from 0.51 to 1.81, respectively. Hence, if exposure were closer to the upper bound estimates, the possibility of an effect on some consumers **CANNOT BE EXCLUDED.** Breast-fed 3-month old infants are predicted to hâve a lead exposure that is below the $BMDL_{01}$ intake value of 0.50 ug/kg b.w. per day for neurodevelopmental effects. Lead exposure based on lower bound assumptions in both average and high 3-month old infant consumers of infant formula is below the $BMDL_{01}$, **BUT MAY EXCEED** this level, based on upper bound estimates. […]

Scientific Opinion on Lead in Food, EFSA 2010 - SUMMARY

Confidence

- Opposite of hedge: Confidence
- The experts express strong commitment to their proposition or chosen method. The experts want to stress that their statement is correct
- Not usual/conventional language for scientists

Confidence

	US	EU	Total
BioHazard	28% (2/7)	24% (7/29)	25% (9/36)
Contaminant	28% (2/7)	**40%** (15/37)	39% (17/44)
Total	28% (4/14)	33% (22/66)	**32%** (26/80)

% of summaries that include at least one sentence expressing Confidence

Confidence is expressed in about 1/3 of summaries

More frequently used in Europe for Contaminants

Examples (EU)

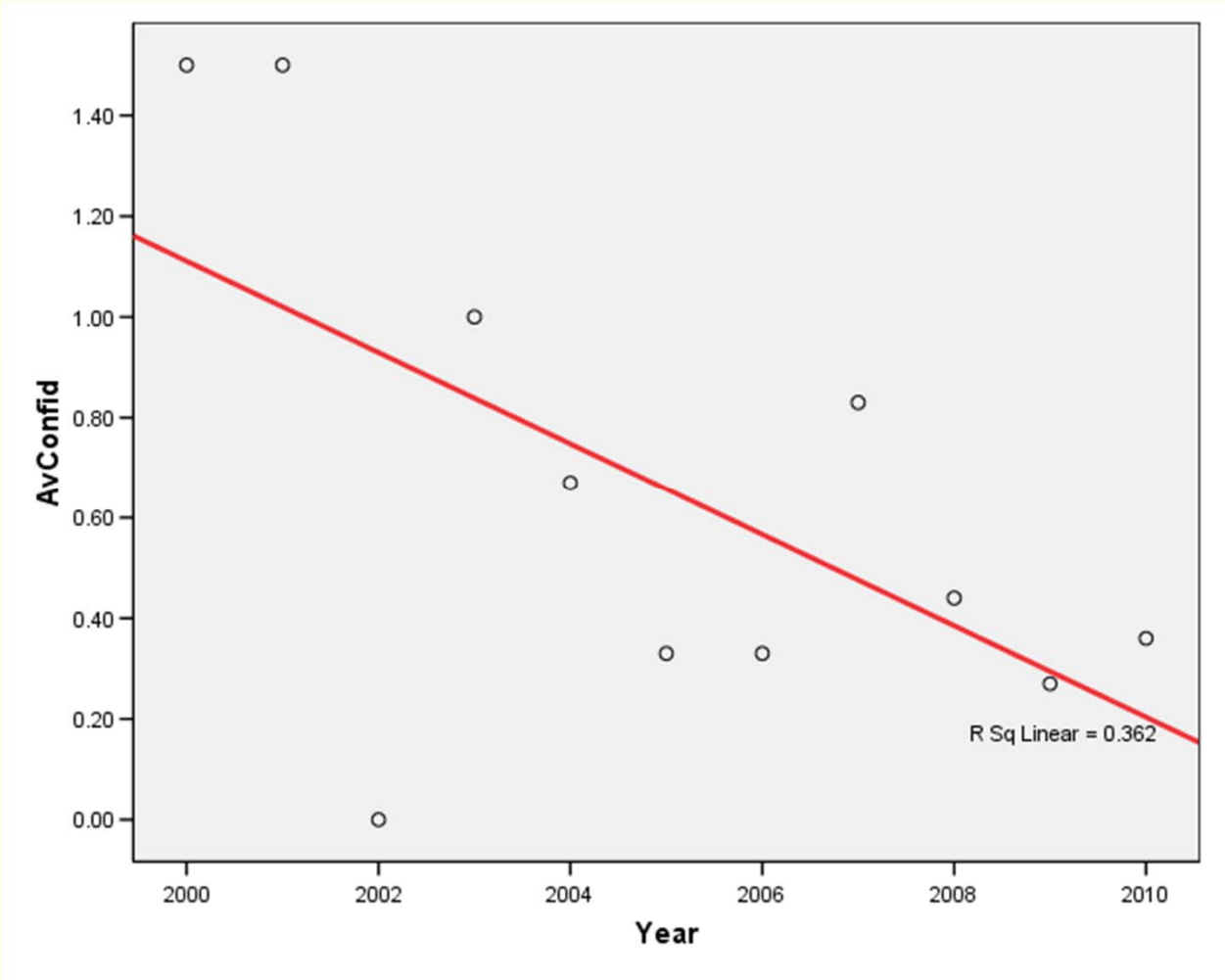
- In a more likely scenario with a daily consumption of 10% contaminated Irish pork for a mean consumer of pork fat for the respective period of the incident (90 days), at the highest recorded concentration of dioxins (200 pg WHO-TEQ/g fat), the body burden would increase by approximately 10%. **EFSA considers this increase in body burden of no concern for this single event.**

Dioxins (in pork), EFSA, 2008

- Evaluation of the few available national dietary exposure data indicated that a **reasonable approximation** of European diets could be obtained from the GEMS/Food Consumption Cluster Diets database, **and the Contam Panel therefore used these data i**n estimating dietary exposure to aflatoxins from foods other than almonds, hazelnuts and pistachios.

Aflatoxin, EFSA, 2007

Expression of confidence (2000 – 2010)



Average number of expressions of confidence per document per year

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.247[a]	.061	.024	.770

a. Predictors: (Constant), cathaz#, country#, VAR00001

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	168.029	75.991		2.211	.030
	Year1	-.083	.038	-.266	-2.204	.031
	EU vs. US	-.234	.241	-.115	-.973	.334
	Biohazard vs. Contaminant	.083	.177	.054	.471	.639

a. Dependent Variable: Confidence

Regression of the number of times confidence is expressed in a document on year, country and type of hazard (n=80)

Precaution

- Experts may express their choice of being cautious or relying on other work that is cautious; e.g. , in working with the worst case scenario
- It creates a form of certainty by overestimating the risk, by being conservative, it can increase the certainty that there is no harm.

- Precaution is expressed in 13% of summaries
- Interestingly
  - It appears to be more frequent in the US
    - US : 21% of summary (3/14)
    - EU : 12 % of summary (8/66)
  - On the 11 documents: 5 are related to the risk assessment of prion diseases (BSE/TSE), between 2005-2008; one of the most controversial health risks in the 2000s

Examples

- Referring back to the gelatine opinion, **this is a worst case consumption scenario** where all the daily human dose of gelatine is assumed to be bovine bone derived (when it is more likely to be 1-5%).

BSE, Efsa, 2006

- The CONTAM Panel considered the impact of the uncertainties on the risk assessment of exposure to uranium from food and water consumption and concluded that its assessment of the risk **is likely to be conservative** in the high exposure scenarios – i.e. **more likely to overestimate** than to underestimate the risk.

Uranium, Efsa,2009

Conclusion

- Communicating Uncertainty at the heart of the confrontation between 2 epistemic cultures
  - Risk Assessors trying to moderate their certainty
  - Risk Managers hoping for the most certain statements
- Need for more formalization

- How this language be formalized?
  - Types of uncertainty may be filled out systematically at the end of the document (with their magnitude)
  - Hedge: to be avoided
  - Characterisation of the level of agreement among the expert
  - Characterisatin of the level of confidence (very high confidence -> very low confidence)

- The formalization would allow to help Risk Managers in managing unknows, ignorance, uncertainty
- Communicating uncertainty betweens experts and regulators is crucial to avoid that public directly face uncertainty…

Managing Uncertainty