



AMBIGUITY

UNCERTAINTY

**Eating the Pudding**  
20yrs experience with  
structured expert judgment

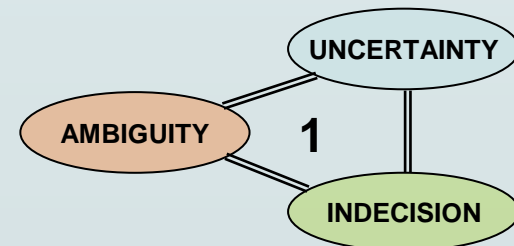
INDECISION

Roger Cooke  
Resources for the Future  
Dept. Math, Delft Univ. of  
Technology,  
Oct. 24, 2011



# Websites & Links

- *Radiation Protection Dosimetry* 90: (2000)  
<http://rpd.oxfordjournals.org/cgi/content/short/90/3/295>
- NUREG EU Probabilistic accident consequence uncertainty analysis  
<http://www.osti.gov/bridge/basicsearch.jsp>  
<http://www.osti.gov/energycitations/basicsearch.jsp>
- EU Probabilistic accident consequence uncertainty assessment using COSYMA  
[http://cordis.europa.eu/fp5-euratom/src/lib\\_docs.htm](http://cordis.europa.eu/fp5-euratom/src/lib_docs.htm)
- RFF workshop expert judgment  
<http://www.rff.org/rff/Events/Expert-Judgment-Workshop.cfm>
- TU Delft Website  
<http://dutiosc.twi.tudelft.nl/~risk/>



## MAIN MENU

- [Home](#)
- [MSc Programme](#)
- [DIAM](#)
- [Research and Publications](#)
- [Courses](#)
- [Staff](#)
- **[Software](#)**
- [Workshops](#)
- [Contact Us](#)
- [Photo Galleries](#)

## General information about our software

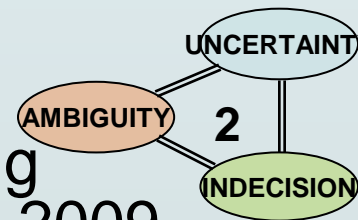
1	<a href="#">Unibalance</a>	766
2	<a href="#">Uninet</a>	894
3	<a href="#">Excalibur</a>	757
4	<a href="#">Unicorn</a>	943

# History Structured Expert Judgment in Risk Analysis

- WASH 1400 (Rasmussen Report 1975)
- IEEE Std 500 (1977)
- Canvey Island (1978)
- NUREG 1150 (1989)
- T-book (Swedish Reliability Data Base 1994)
- USNRC-EU (1995-1997)
- Guidance on Uncertainty and Use of Experts. NUREG/CR-6372, 1997
- Procedures Guide for Structured Expert Judgment, EUR 18820EN, 2000
- Morgan, et al "Best Practice Approaches for Characterizing, Communicating, and Incorporating Scientific Uncertainty in Climate Decision Making 2009

Very Different Guidelines:

The story you hear today is NOT the only story

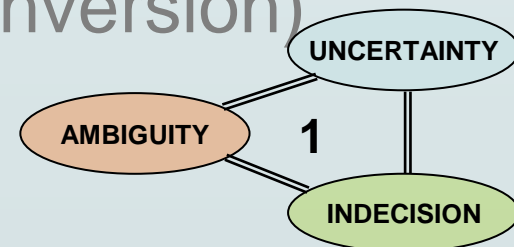


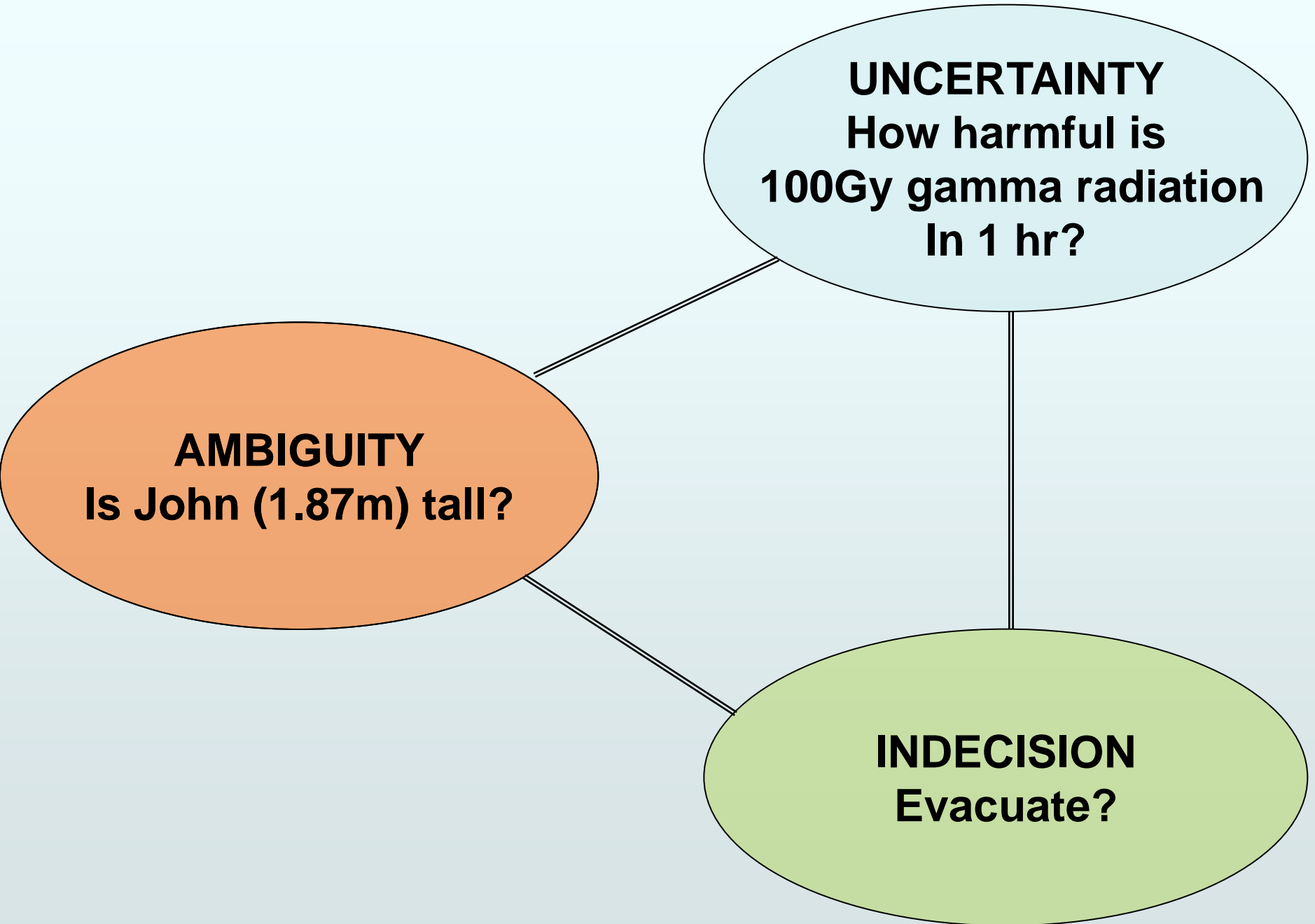
# Overview

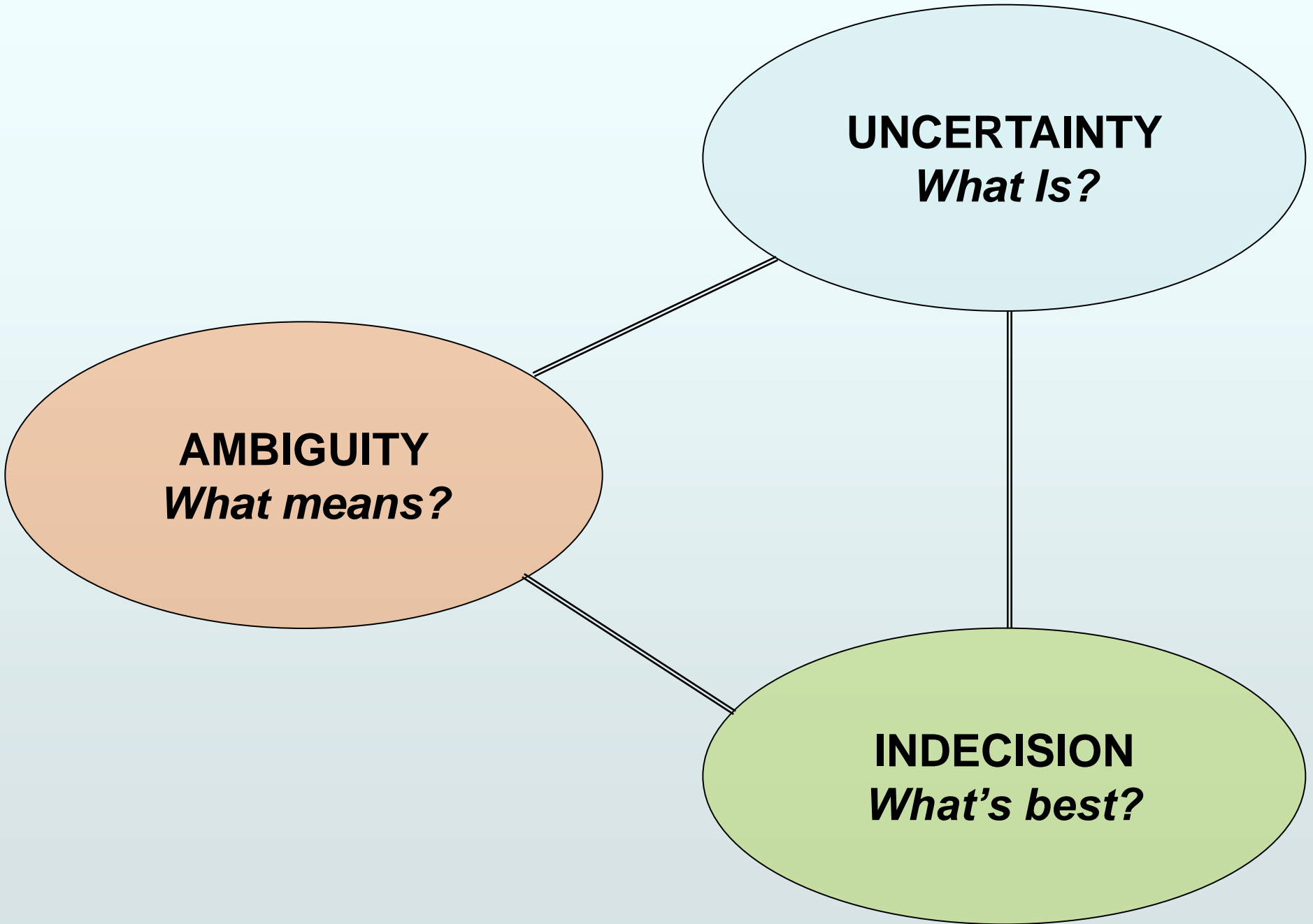
- Foundations 101
- Rational Consensus / Classical Model
- DATA / Validation
- Take Home

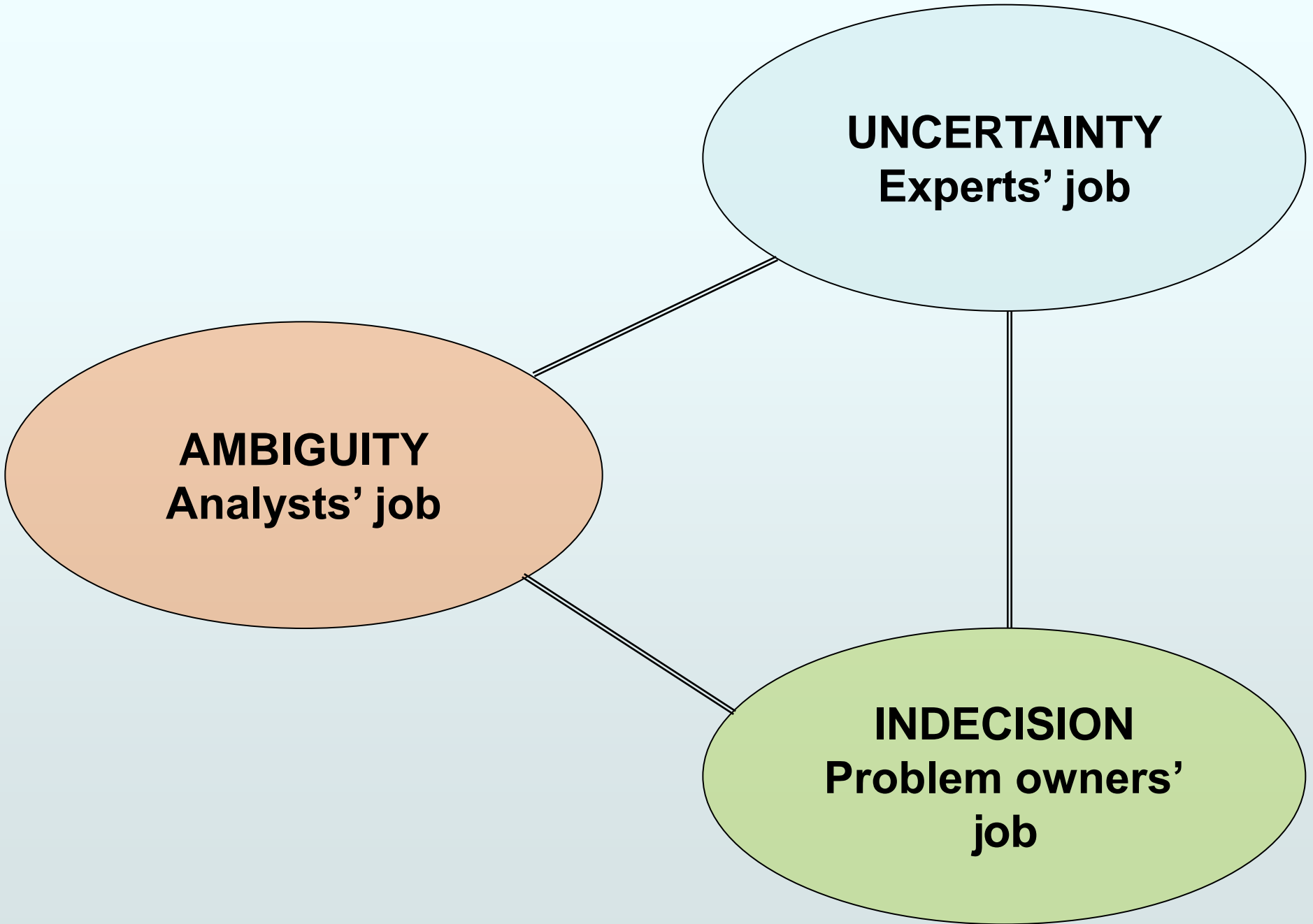
## NOT

- Stakeholder preference (values)
- Dependence
- Fitting models to EJ (probabilistic inversion)











# Christine Todd Whitman Administrator EPA, 2001-2003

“A big part of my frustration was that scientists would give me a range. And I would ask, ‘Please just tell me at which point you are safe, and we can do that.’ But they would give a range, say, from 5 to 25 parts per billion”

Christine Todd Whitman, quoted in *Environmental Science & Technology*  
*Opinion*, April 20, 2005

**YOU are paid to decide  
under uncertainty**

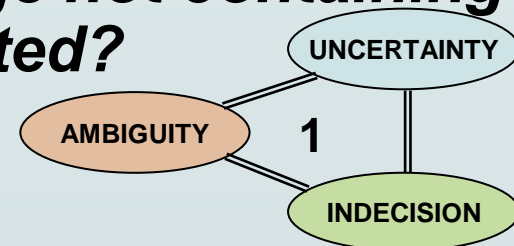
# Operational Definitions

- The philosophy of science: semantic analysis: Mach, Hertz, Einstein, Bohr
- A Modern rendering:

*IF BOB says*

***“The Loch Ness monster exists with degree of possibility 0.0731”***

***to which sentences in the natural language not containing “degree of possibility” is BOB committed?***



# Operational definition: Subjective probability

**Consider two events:**

F: France wins next World Cup Soccer tournament

US: USA wins next World Cup Soccer tournament.

**Two lottery tickets:**

L(F): worth \$10,000 if F, worth \$1000 otherwise

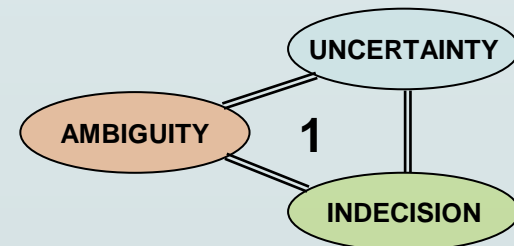
L(US): worth \$10,000 if US, worth \$1000 otherwise.

**John may choose ONE .**

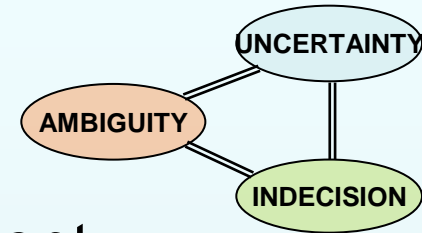
*John's degree belief (F)  $\geq$  John's degree belief (US)*

is operationalized as

*John chooses L(F) in the above choice situation*



# Fundamental Theorem of Decision Theory



**If, eg :**

B: Belgium wins next World Cup Soccer tournament.

$L(F) > L(US); L(US) > L(B); \Rightarrow L(F) > L(B) ??$

$L(F) > L(US) \Rightarrow L(F \text{ or } B) > L(US \text{ or } B) ??$

(plus some technical axioms)

**Then** There is a **UNIQUE** probability **P** which represents degree of belief:

$\text{DegBel}(F) > \text{DegBel}(US) \Leftrightarrow P(F) > P(US)$

**AND** a Utility function, unique up to 0 and 1, that represents values:

$L(F) > L(US) \Leftrightarrow \text{Exp'd Utility}(L(F)) > \text{Exp'd Utility}(L(US))$

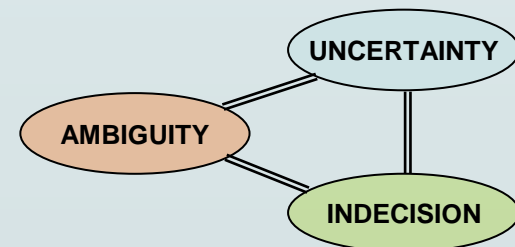
**PROOF** (4 hrs) [EJCoursenotes-Theory-Rational-Decision.doc](#)

# **RATIONAL CONSENSUS**

# Goals of an EJ study

- Census
- Political consensus
- Rational consensus

[EJCoursenotes\\_review-EJ-literature.doc](#)



# EJ for RATIONAL CONSENSUS:

[RESS-TUDdatabase.pdf](#)

Parties pre-commit to a method which satisfies necessary conditions for scientific method:

*Traceability/accountability*

*Neutrality (don't encourage untruthfulness)*

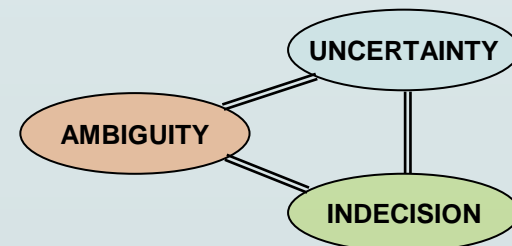
*Fairness (ab initio, all experts equal)*

*Empirical control (performance meas't)*

Withdrawal post hoc incurs burden of proof.

Goal: comply with principals and combine experts' judgments to get a **Good Probability Assessor**

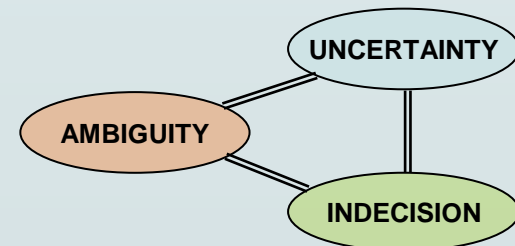
“Classical Model for EJ”



# CLASSICAL MODEL

What is a GOOD subjective probability assessor?

- **Calibration, statistical likelihood**
  - Are the expert's probability statements statistically accurate? P-value of statistical test
- **Informativeness**
  - Probability mass concentrated in a small region, relative to background measure
- Nominal values near truth
- ?





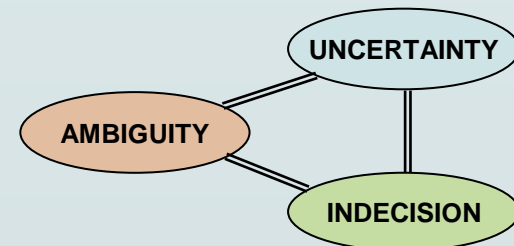
# Performance based score (weight):

## Calibration × information × cutoff

*Requires that experts assess uncertainty for variables for which we (will) know the true values:*

**Calibration / performance / seed**      *variables*

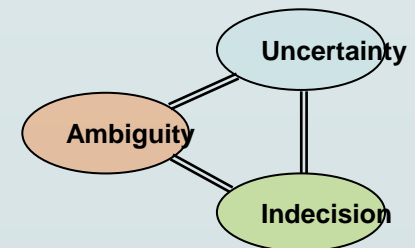
*any expert, or combination of experts (Decision Maker, dm), can be regarded as a statistical hypothesis*



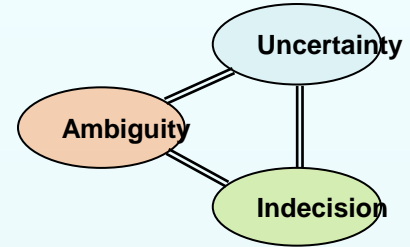
# Performance score is a strictly proper scoring rule

Expert maximizes long run expected score by, and only by, stating percentiles which (s)he believes

[EJCoursenotes-ScoringRules.doc](#) (4 hrs)



# Combining Experts



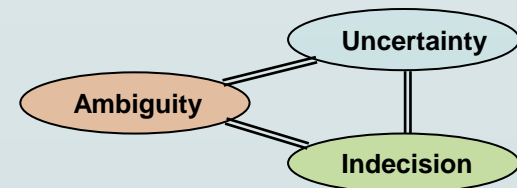
## *Equal weight decision maker*

- Easy
- Sometimes OK
- Sometimes NOT

## *Performance Based Combinations*

- Cut-off chosen to optimize DM performance, linear pool of weighted experts

# Does weighting Matter?

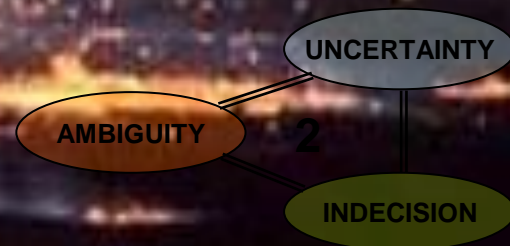


# Harvard-Kuwait SEJ Health Effects of Oil Fires:

## UN Claims commission

All cause mortality, percent increase per 1  $\mu\text{g}/\text{m}^3$  increase in  $\text{PM}_{2.5}$  ([RESS-PM25.pdf](#))

	Amer Cancer Soc. (reanal.)	Six Cities Study (reanal.)	Harvard Kuwait, Equal weights (US)	Harvard Kuwait, Performance weights (US)
Median/best estimate	0.7	1.4	0.9657	0.6046
Ratio 95%/5%	2.5	4.8	257	63





68% of 84 NIS established since 1959 associated with transoceanic shipping (Ricciardi 2006)



## Econ. Damages Invasive Species in Great Lakes (13 calibration vbls)

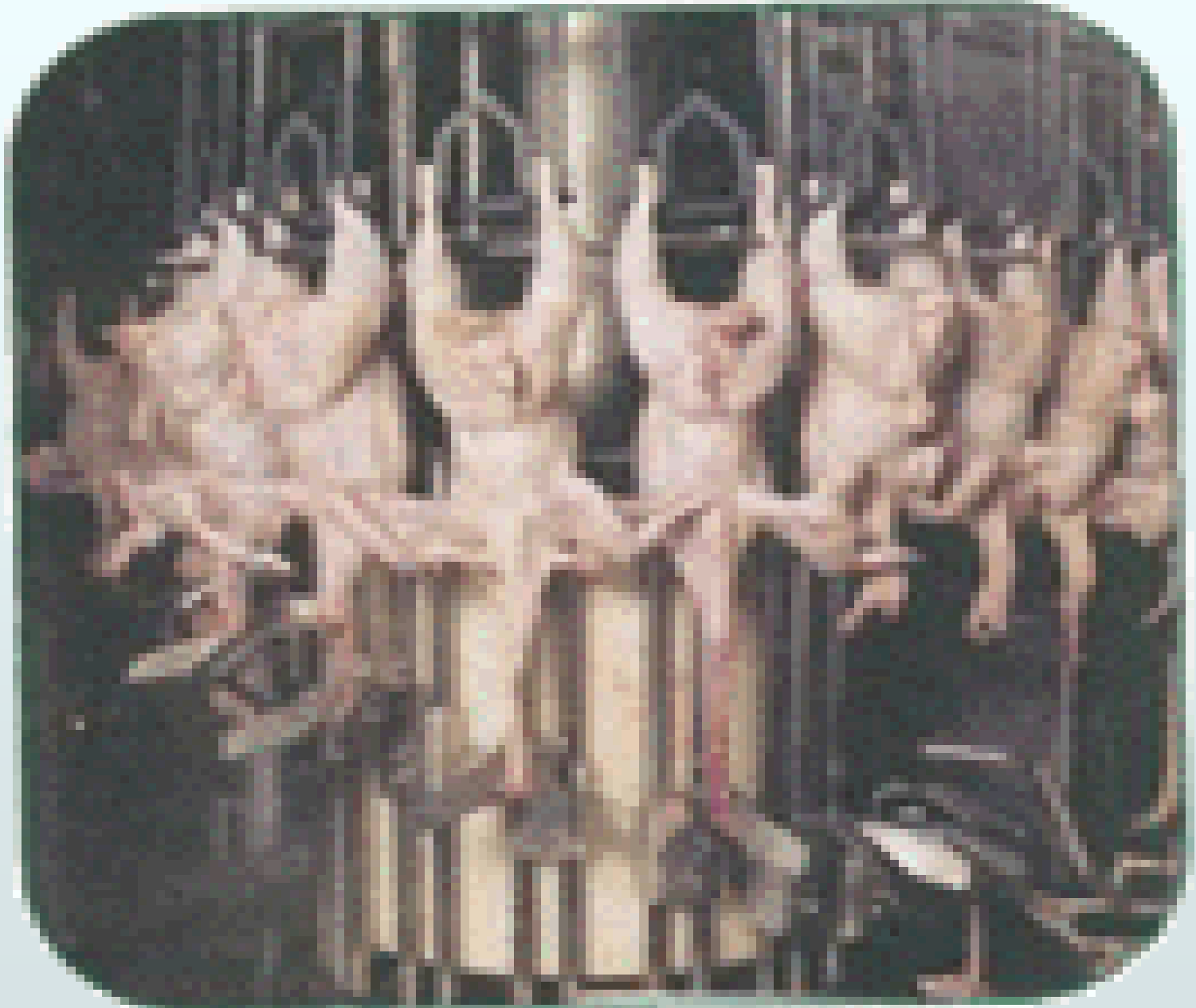
Expert	P-Value	Inf wrt Bckgr	Unnormalized wgt	Normalized wgt
1	4.03E-05	0.940	3.79E-05	1.96E-04
2	9.65E-02	0.702	6.77E-02	3.50E-01
3	1.17E-04	1.259	1.48E-04	7.63E-04
4	1.17E-04	1.003	1.18E-04	6.09E-04
5	7.47E-04	1.131	8.44E-04	4.36E-03
6	4.54E-01	0.274	1.24E-01	6.43E-01
7	1.17E-04	0.990	1.16E-04	6.00E-04
8	4.86E-06	1.367	6.64E-06	3.43E-05
9	1.91E-09	2.860	5.47E-09	2.83E-08
Perf Dm	9.28E-01	0.259	2.40E-01	
Eq DM	<b>4.41E-02</b>	0.307	1.35E-02	

# Robert Wood Johnson Foundation

<b>Id</b>	<b>Calibr.</b>	<b>Mean relative</b>	<b>Mean relative</b>	<b>Numb</b>	<b>UnNormalized</b>	<b>Normaliz. weigl</b>
		<b>total</b>	<b>realization</b>	<b>real</b>	<b>weight</b>	<b>without DM</b>
<b>NE01</b>	<b>7.341E-009</b>	<b>2.1</b>	<b>2.156</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>NE02</b>	<b>0.0003719</b>	<b>0.847</b>	<b>1.002</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>NE03</b>	<b>0.03297</b>	<b>1.282</b>	<b>1.447</b>	<b>10</b>	<b>0.04771</b>	<b>1</b>
<b>NE04</b>	<b>7.832E-005</b>	<b>1.122</b>	<b>1.735</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>perf-dm</b>	<b>0.03297</b>	<b>1.282</b>	<b>1.447</b>	<b>10</b>	<b>0.04771</b>	
<b>eq-dm</b>	<b>0.3684</b>	<b>0.3958</b>	<b>0.6951</b>	<b>10</b>	<b>0.2561</b>	



# Campylobacter: Chicken Processing Model



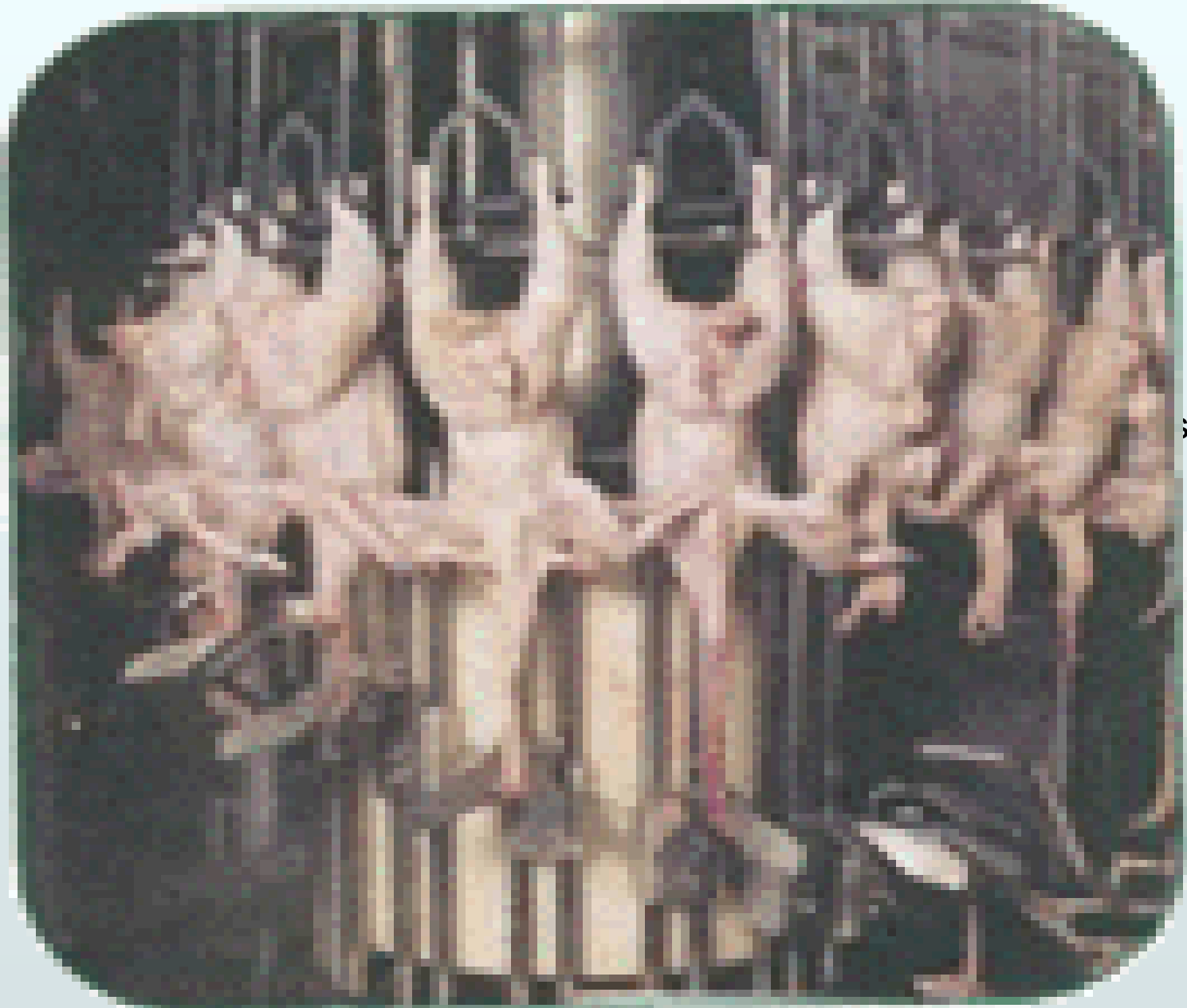
# Campylobacter Infection

<b>Id</b>	<b>Calibr.</b>	<b>Mean relative</b>	<b>Mean relative</b>	<b>Numb</b>	<b>UnNormalized</b>	<b>Normaliz.weight</b>
		<b>total</b>	<b>realization</b>	<b>real</b>	<b>weight</b>	<b>without DM</b>
<b>1</b>	<b>0.002809</b>	<b>1.622</b>	<b>1.003</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>2</b>	<b>0.01397</b>	<b>2.563</b>	<b>1.337</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>3</b>	<b>0.6827</b>	<b>0.7621</b>	<b>0.5744</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>4</b>	<b>0.002809</b>	<b>1.893</b>	<b>0.7432</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>5</b>	<b>0.2282</b>	<b>2.806</b>	<b>0.2621</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>6</b>	<b>0.6827</b>	<b>11.19</b>	<b>0.73</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>7</b>	<b>0.8283</b>	<b>3.662</b>	<b>1.48</b>	<b>10</b>	<b>1.226</b>	<b>1</b>
<b>8</b>	<b>0.6827</b>	<b>1.946</b>	<b>0.7675</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>9</b>	<b>0.0002637</b>	<b>1.374</b>	<b>1.129</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>10</b>	<b>4.079E-006</b>	<b>2.495</b>	<b>2.122</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>11</b>	<b>0.0007993</b>	<b>1.899</b>	<b>1.028</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>12</b>	<b>1.371E-008</b>	<b>2.145</b>	<b>1.895</b>	<b>10</b>	<b>0</b>	<b>0</b>
<b>perf-dm</b>	<b>0.8283</b>	<b>3.662</b>	<b>1.48</b>	<b>10</b>	<b>1.226</b>	
<b>eq-dm</b>	<b>0.4735</b>	<b>0.5056</b>	<b>0.2359</b>	<b>10</b>	<b>0.1117</b>	

# Expert 170

```
• Expert no. : 7 Expert name: GM
• Items
• 1 (L) [-----*-----]
• Real :::::::::::::::::::::::::::::::::::::::::::::::::::::::#:
Expert no. : 10 Expert name: PE
• Items 2 (L) [-----*-----]
• .1 (L) Real ::::::::::::::::::::::::::::::::::::::::::::::#;
• Real :::::::::::::::::::::::::::::::::::::::::::::::#:
• 3 (L) [-----*-----]
• .2 (L) Real :::::::::: [-----*-----]::: #:
• Real :::::::::::::::::::::::::::::::::::::::#:
• 4 (L) [-----*-----]
• .3 (L) Real ::::::::::::::::::::::::::::::#:; [-*-]
• Real :::::::::::::::::::::::::::::::#:
• 5 (L) [-----*-----]
• .4 (L) Real ::::::::::::::::::::::#:; [-*-]#;
• Real :::::::::::::::::::::::#:
• 6 (U) [-----*-----]
• .5 (L) Real ::::::::::::::::::::::#:; [ ]::: #:
• Real :::::::::::::::::::::::#:
• 7 (U) [-----*-----] [*]
• .6 (U) Real :::::::::: [---*---]::: #:
• Real :::::::::::::::::::::::#:
• 8 (U) [-----*-----]
• .7 (U) Real :::::::::: [-----*-----]::: #:
• Real :::::::::::::::::::::::#:
• 9 (L) [-----*-----]
• .8 (U) Real :::::::::: #: [-----*-----]
• Real :::::::::::::::::::::::#:
• 10 (L) [-----*-----]
• .9 (L) Real :::::::::: #: [-*-]
• Real :::::::::::::::#:
• 10 (L) [-*-]
• Real :::::::::::::::#:
```

# Campylobacter: Chicken Processing Model



# **DATA / VALIDATION**

# Calibration questions for PM<sub>2.5</sub>

[RESS-PM25.pdf](#)

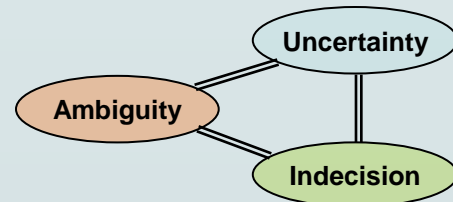
In London 2000, weekly average PM<sub>10</sub> was 18.4 µg/m<sup>3</sup>.  
What is the ratio:

# non-accidental deaths in the week with the **highest** average  
PM<sub>10</sub> concentration (33.4 µg/m<sup>3</sup>)

---

Weekly average # non-accidental deaths.

5% : \_\_\_\_\_ 25%: \_\_\_\_\_ 50% : \_\_\_\_\_ 75%: \_\_\_\_\_ 95%: \_\_\_\_\_



Very **informative** assessors may be statistically **least accurate**

[PM25-Range-graphs.doc](#)

**Experts are sometimes well calibrated**

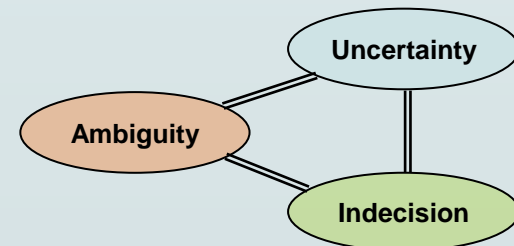
[AMS-OPTION-TRADERS-RANGE-GRAPHS.doc](#)

[realestate-range graphs.doc](#)

[RWJF-CoveringKids-Penn-RangeGraphs.doc](#)

**Sometimes not**

[GL-invasive-species-range-graphs.doc](#)



# Experts sometimes agree

[Dispersion-USNRC-EU-RANGE-GRAPHS.doc](#)

# And sometimes don't

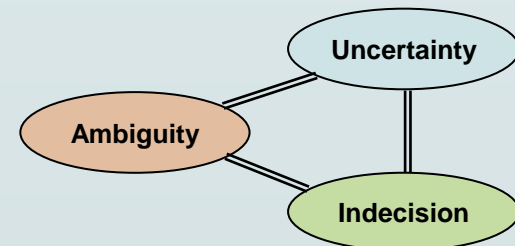
[Campy-range-graphs.doc](#)

[Earlyhealth-USNRC-EU-Range-graphs.doc](#)

# Classical model usually works, not always

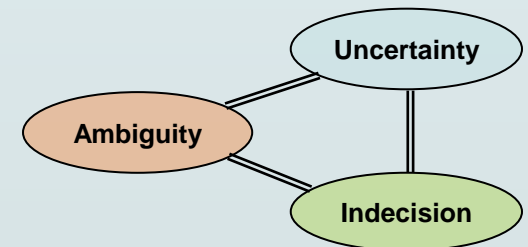
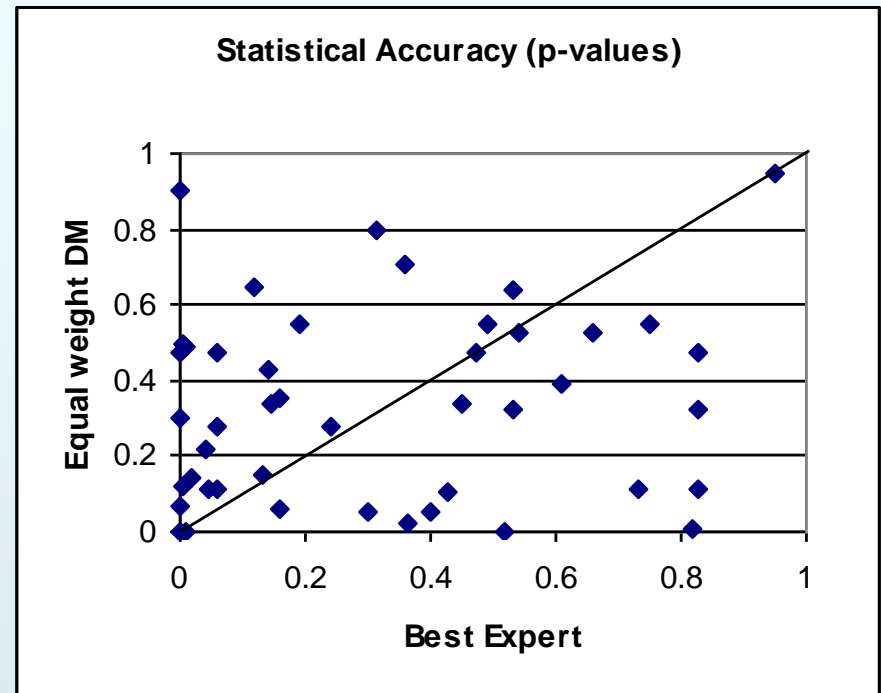
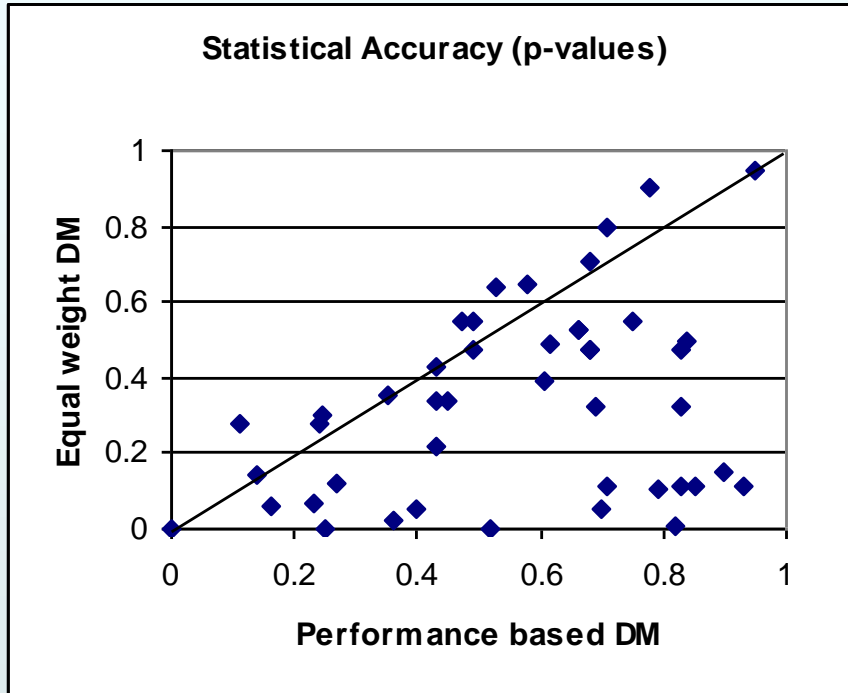
[Soil-animal-USNRC-EU-range-graphs.doc](#)

[RWJ – Nebraska- range graphs.docx](#)

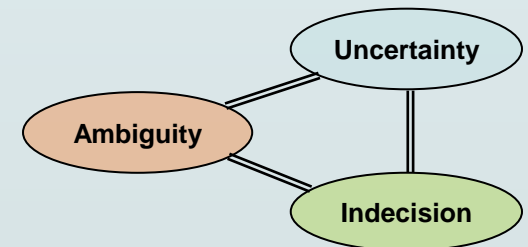
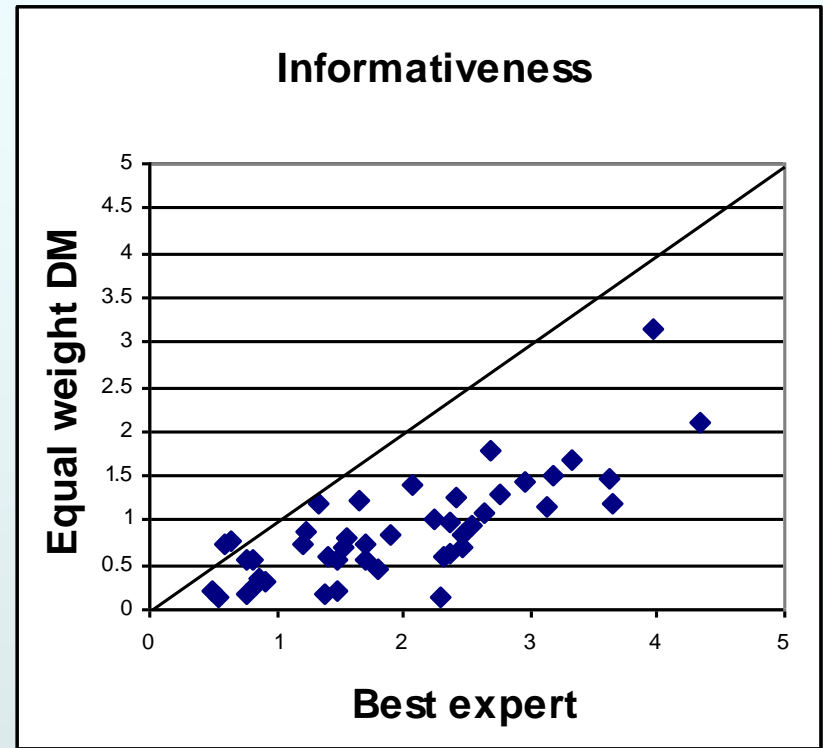
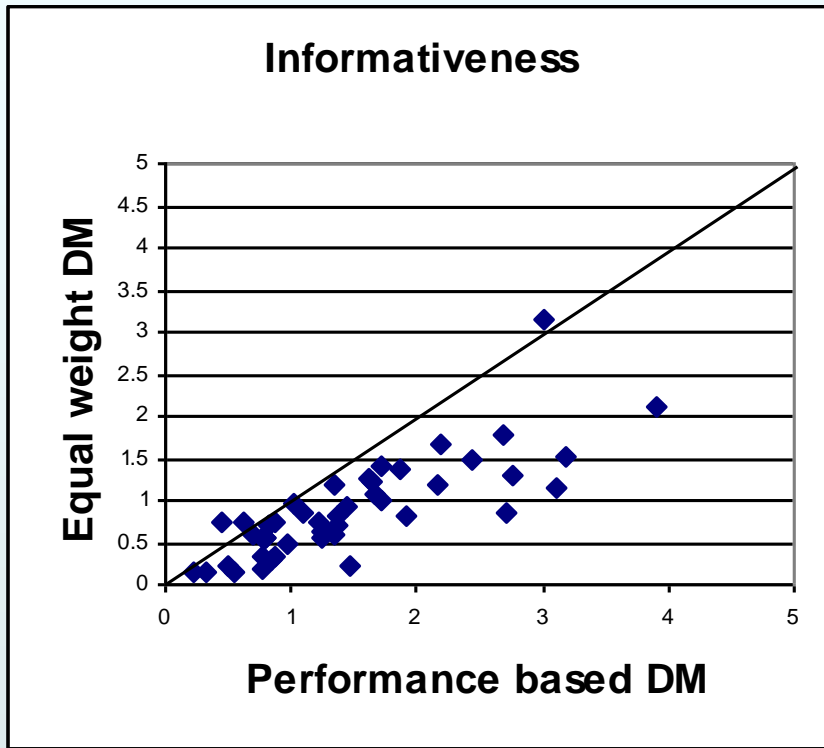




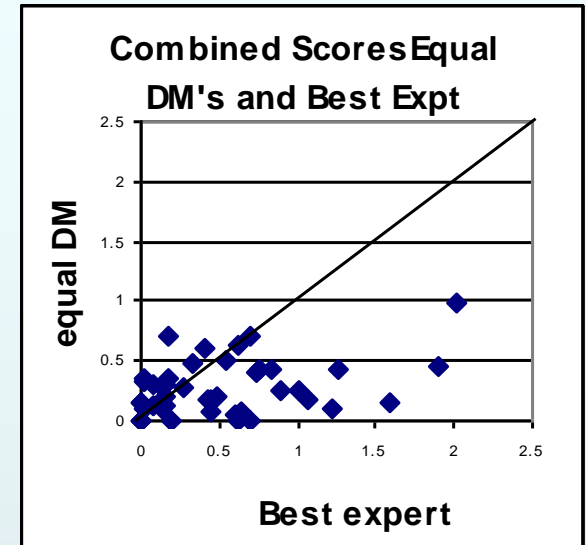
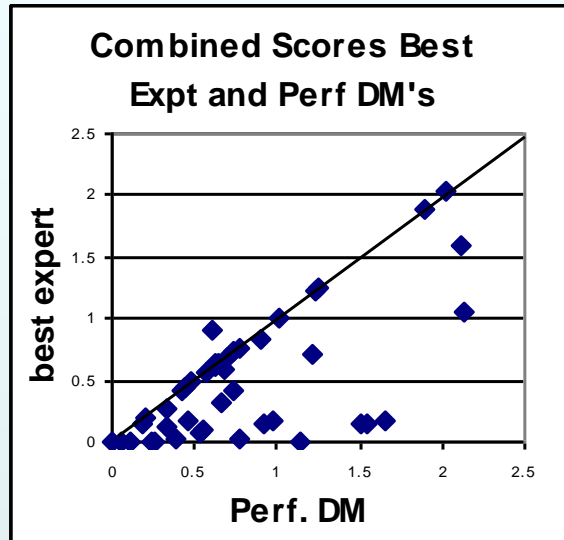
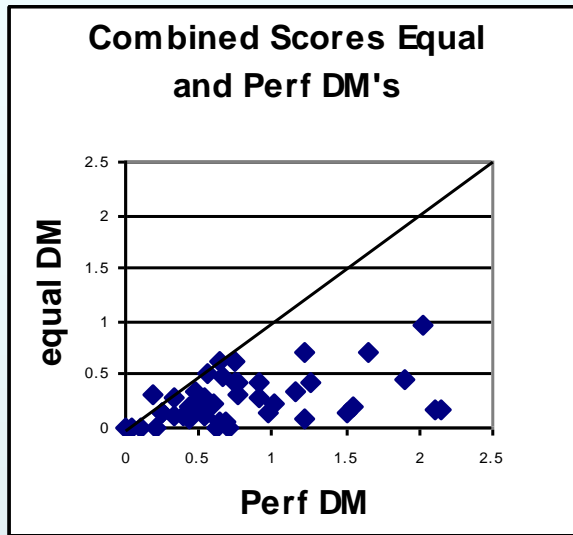
# TUD EJ database - calibration scores



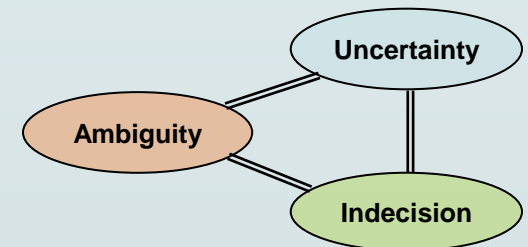
# TUD EJ database - information scores



# TUD EJ database – combined scores

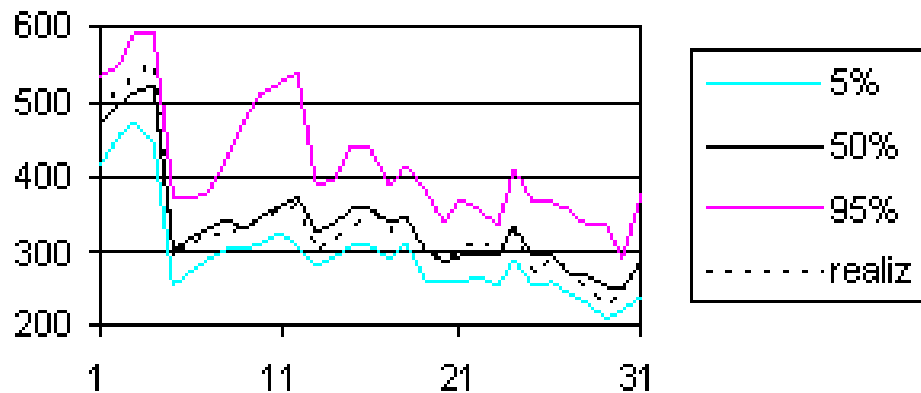


However, performance scores are calculated within-sample: weights are calculated on the basis of available data (realizations), and performance scores are then calculated using the same data.



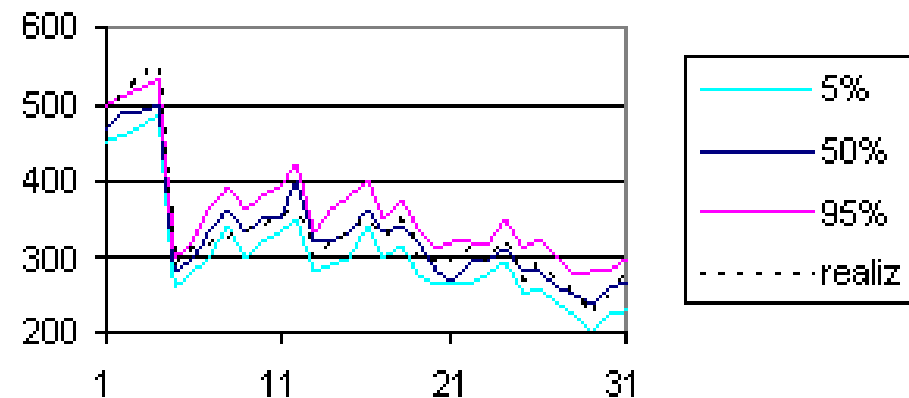
# True out-of-sample validation

Real Estate Risk: Equal weight DM



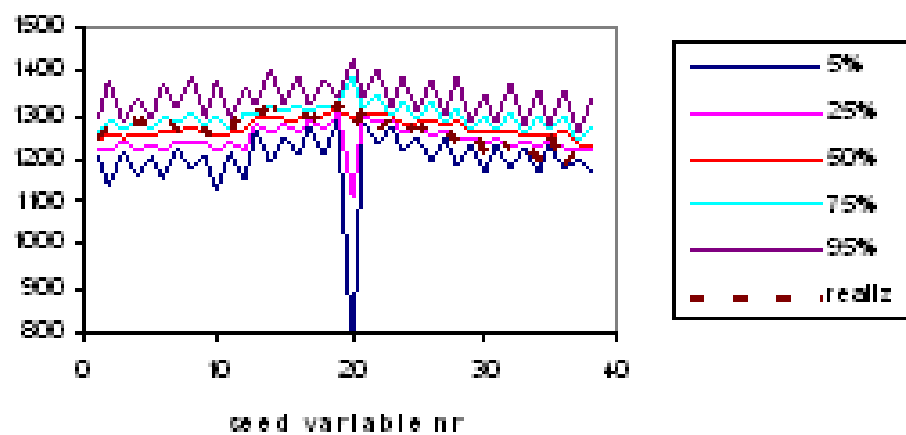
vbls 1-16 = seed; vbls 17-31 = vbls of interest

Real Estate Risk: Performance based DM

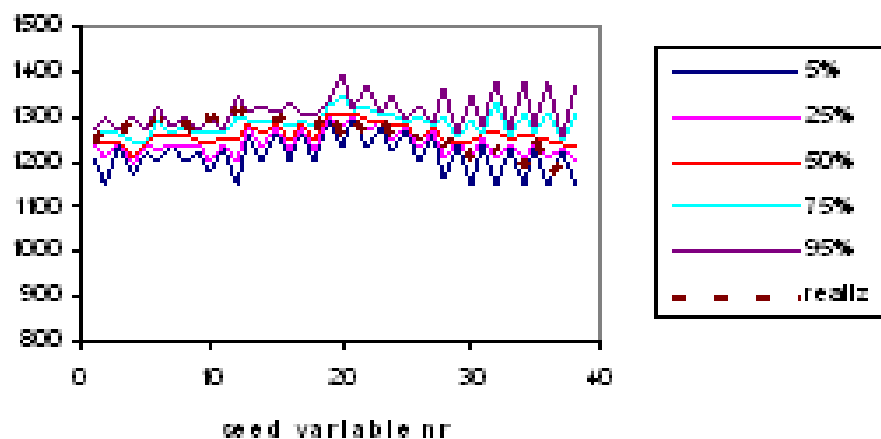


vbls 1-16 =seed; vbls 17-31 = vbls. of interest

### AEX Equal DM



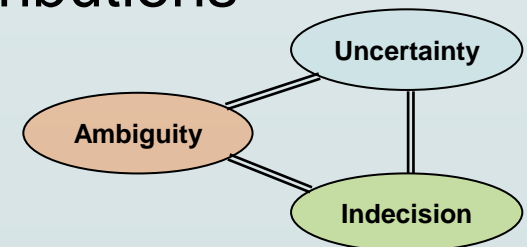
### AEX Perf Dm



# ***PROXY Out-of-sample validation***

Remove-One-at a-Time (ROAT) (Clemen 2008)\*

1. Exclude seed variable  $i$
2. Calculate PW based on the remaining  $N-1$  seed variables
3. Record the combined distribution for seed variable  $i$  using weights calculated in step 2
4. Set  $i=i+1$
5. If  $i \leq N$ . return to step 1 and repeat
6. After collecting the  $N$  combined distributions, calculate the score for this set of distributions



\*Clemen RT. Comment on Cooke's classical method. RESS 2008;93:760-765

# ROAT findings

Only 9/14 times did PW-DM better than EW-DM! Not statistically convincing

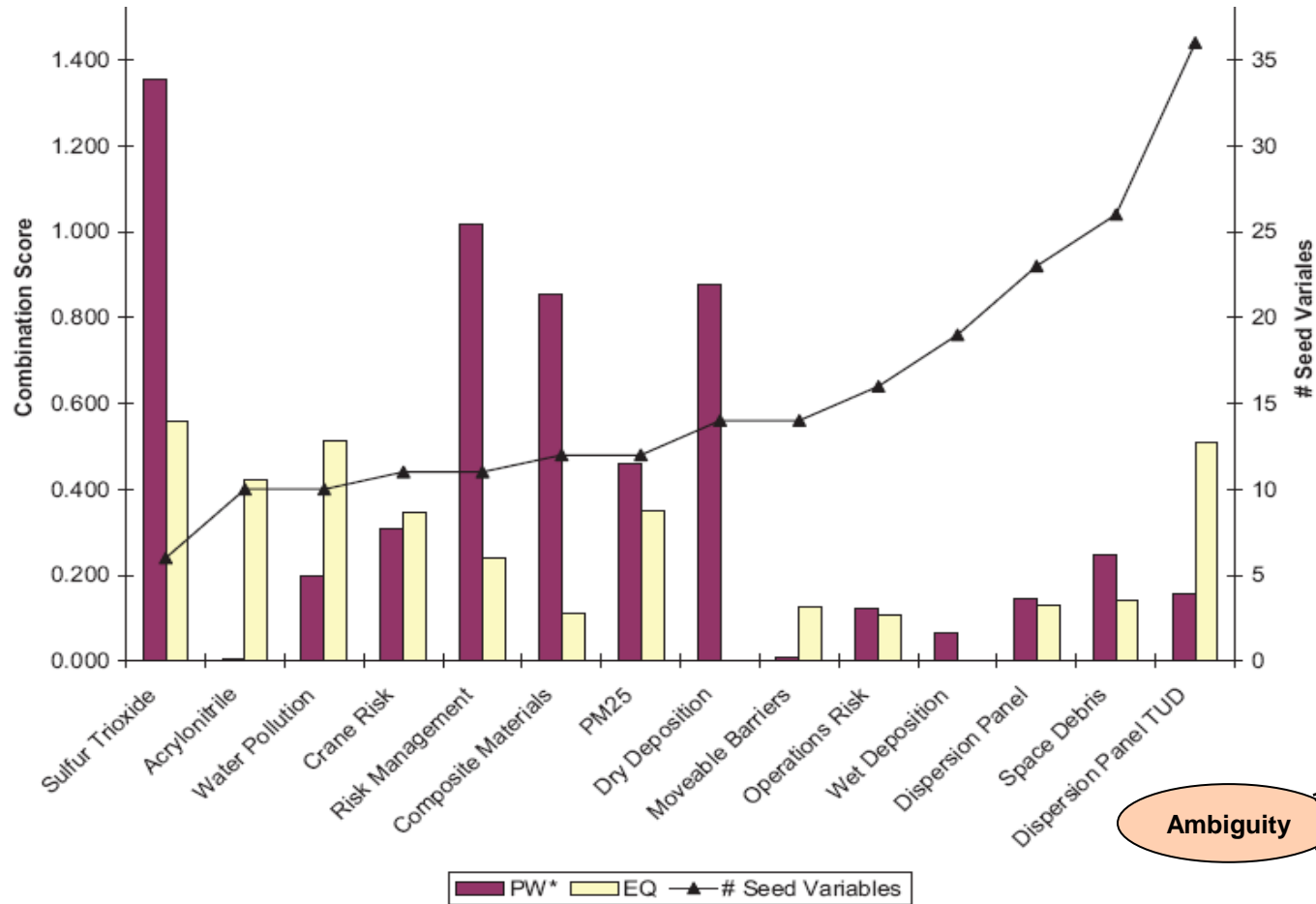
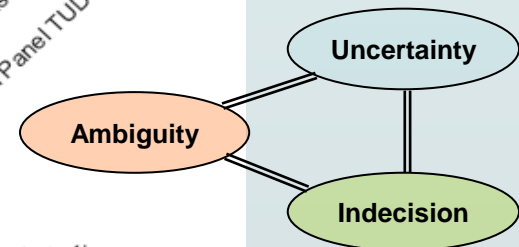
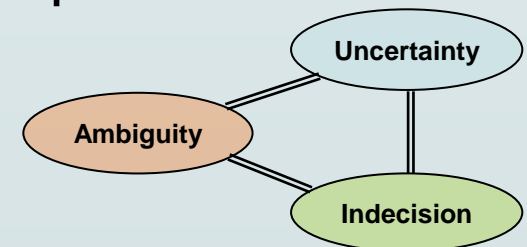


Fig. 1. Combination scores for PW\* and EQ and number of seed variables for 14 risk-assessment studies.



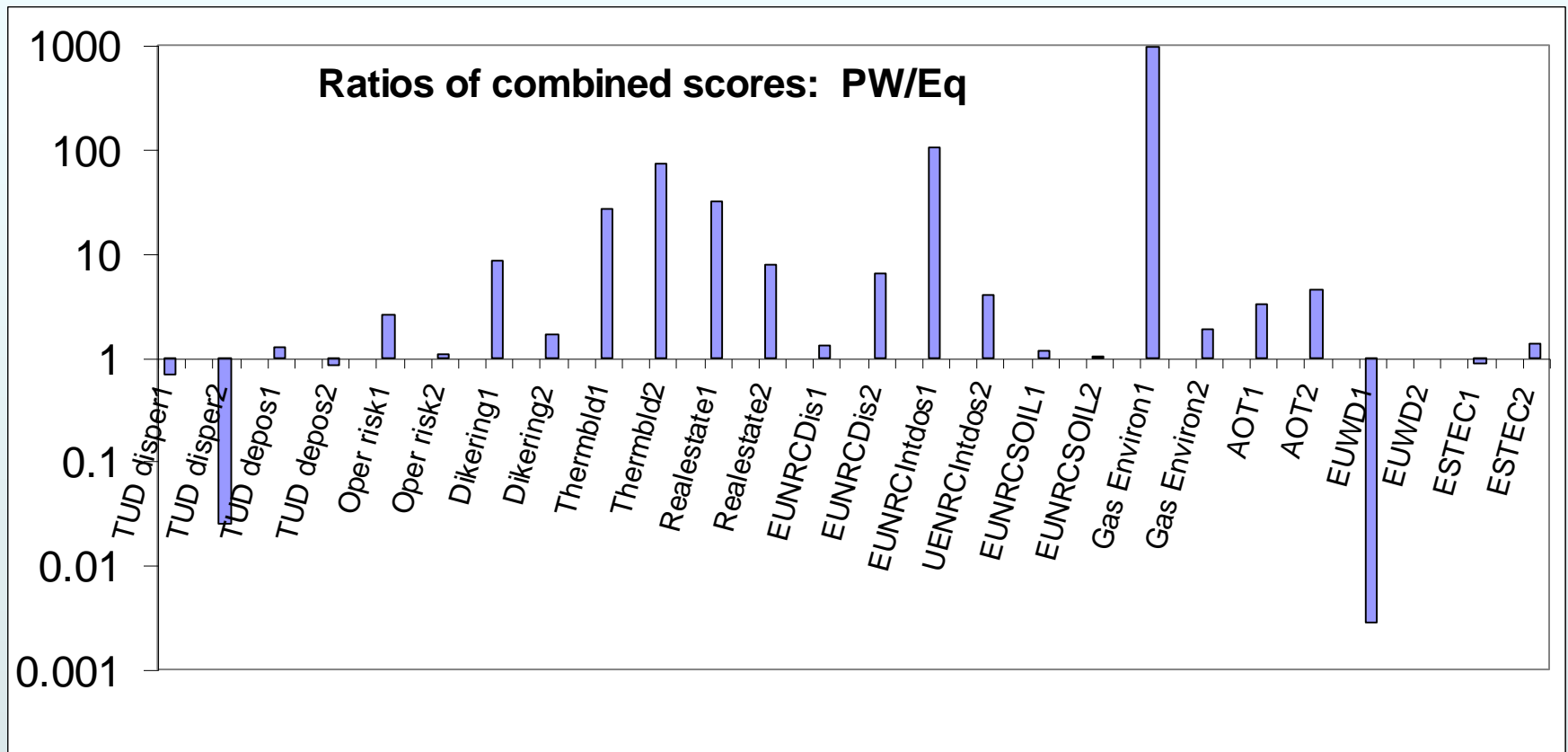
# *Issue with ROAT*

- If seed question  $i$  is removed, those experts that did well on this question will receive less weight
- This introduces more than “slight” (?) bias against PW-DM
- Alternative: half-sample validation:
  - split sample in half
  - see how well DM based on performance on first half does on second half (and vice versa)
  - need at least 16 question for statistical power

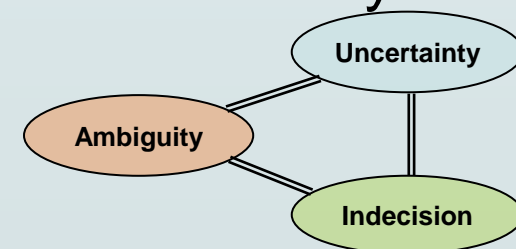




# Results half-sample validation



- PW-DM outperforms EW-DM in 20/26 cases – statistically significant
- Discussion still in progress...



# ROAT volatility of wahts

Table 1: Weights for ROAT in Eudisp

Removed variable	Expert							
	1	2	3	4	5	6	7	8
None	0	0	0	0.7683	0.2317	0	0	0
1	0	0	0	0.8086	0.1914	0	0	0
2	0	0	0	0.7928	0.2072	0	0	0
3	0	0	0	0.8071	0.1929	0	0	0
4	0	0	0	0.7303	0	0.2697	0	0
5	0	0	0	0.4094	0.5906	0	0	0
6	0	0	0	0.7022	0.2978	0	0	0
7	0	0	0	0.6777	0.3223	0	0	0
8	0	0	0	0.7928	0.2072	0	0	0
9	0	0	0	0.806	0.194	0	0	0
10	0	0	0	0.8645	0.1355	0	0	0
11	0	0	0	0.7003	0.1638	0	0	0.1359
12	0	0	0	0.7042	0.1632	0	0	0.1325
13	0	0	0	0.7659	0.2341	0	0	0
14	0	0	0	0.6996	0.1654	0	0	0.135
15	0	0	0	0.6287	0.1637	0	0.07593	0.1317
16	0	0	0	0.704	0.296	0	0	0
17	0	0	0	0.6996	0.1655	0	0	0.1349
18	0	0	0	0.6286	0.1638	0	0.07588	0.1317
19	0	0	0	0.704	0.296	0	0	0
20	0	0	0	0.6499	0.1537	0	0.07101	0.1254
21	0	0	0	0.5016	0.1307	0	0	0.3677
22	0	0	0	1	0	0	0	0
23	0	0	0	0.4094	0.5906	0	0	0

# ROAT bias

P(Heads) experts 1 & 2:  $P_1(\text{Heads}) = 0.8$ ,  $P_2(\text{Heads}) = 0.2$ :

DM's probability for heads =  $P_{dm} = wP_1 + (1-w)P_2$ ,

Weights proportional to likelihood of each expert's distribution, given the data. Observe **10 Heads** and **10 Tails**: experts' likelihood ratio is

$$\frac{0.8^{10} \times 0.2^{10}}{0.2^{10} \times 0.8^{10}} = 0.8^0 \times 0.2^0 = 1.$$

$$\frac{0.8^{10} \times 0.2^9}{0.2^{10} \times 0.8^9} = 0.8 / 0.2 = 4$$

$w = 1/2$ .

If # Tails = 9  $\Rightarrow$  weight ratio is 4 and  $w = 4/5$

$P_{dm}(\text{Heads}) = (4/5) \times 0.8 + (1/5) \times 0.2 = 0.68$ . ...used to predict a TAIL!!

**STRONG BIAS.**

True out of sample with 20 fresh observations PW model would use  $w = 1/2$ .

TRUE PW / ROAT likelihood ratio =  $(1/2)^{20} / 0.32^{20} = 7523$ .

# Studies of EJ DATA:

Special issue on expert judgment Reliability Engineering & System Safety, 93, Available online 12 March 2007, *Issue 5, May 2008*.

1. Cooke, R.M., Goossens, L.H.J. (2008) *TU Delft Expert Judgment Data Base*,
2. Shi-Woei Lin and Bier V.M. (2008) *A Study of Expert Overconfidence*
3. Wisse, B. Tim Bedford, T. J. Quigley, J (2008) *Expert Judgement Combination using Moment Methods*,
4. Cooke,R.M. ElSaadany,S, Huang , X (2008) *On the Performance of Social Network and Likelihood Based Expert Weighting Schemes*,
5. Clemen RT.. (2008) "Comment on Cooke's classical method Reliability Engineering & System Safety, 93, Available online 12 March 2007, *Volume 93, Issue 5*, pp 760-765.
6. Cooke, R.M.,. (2008) *Response to Comments*, Special issue on expert judgment Reliability Engineering & System Safety, 93, 775-777, Available online 12 March 2007. *Volume 93, Issue 5, May 2008*.

## ALSO

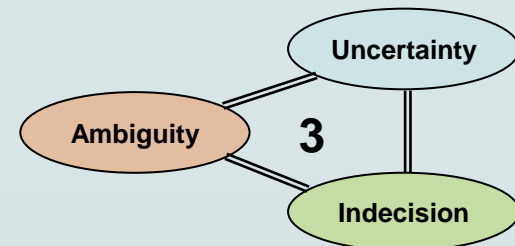
1. Shi-Woei Lin, Chih-Hsing Cheng, (2009) "The reliability of aggregated probability judgments obtained through Cooke's classical model", *Journal of Modelling in Management*, Vol. 4 Iss: 2, pp.149 – 161
2. Shi-Woei Lin; Chih-Hsing Cheng (2008) " Can Cooke's Model Sift Out Better Experts and Produce Well-Calibrated Aggregated Probabilities?" *Proceedings of the 2008 IEEE IEEM*
3. Flandoli, F. Giorgi W.P. Aspinall, W. and Neri A (2010). " Comparing the performance of different expert elicitation models using a cross-validation technique" appearing in *Reliability engineering and System Safety*

# 5 Take home's

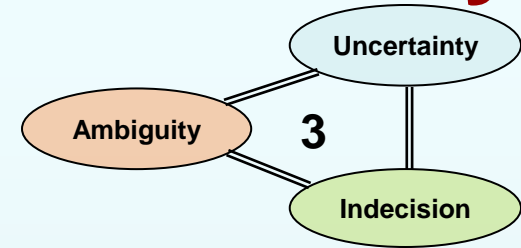
# 1. Expert Judgment is NOT Knowledge

*Scientific method – NOT EJ methods - produces agreement among experts*

EJ is for quantifying ....not removing..... uncertainty.

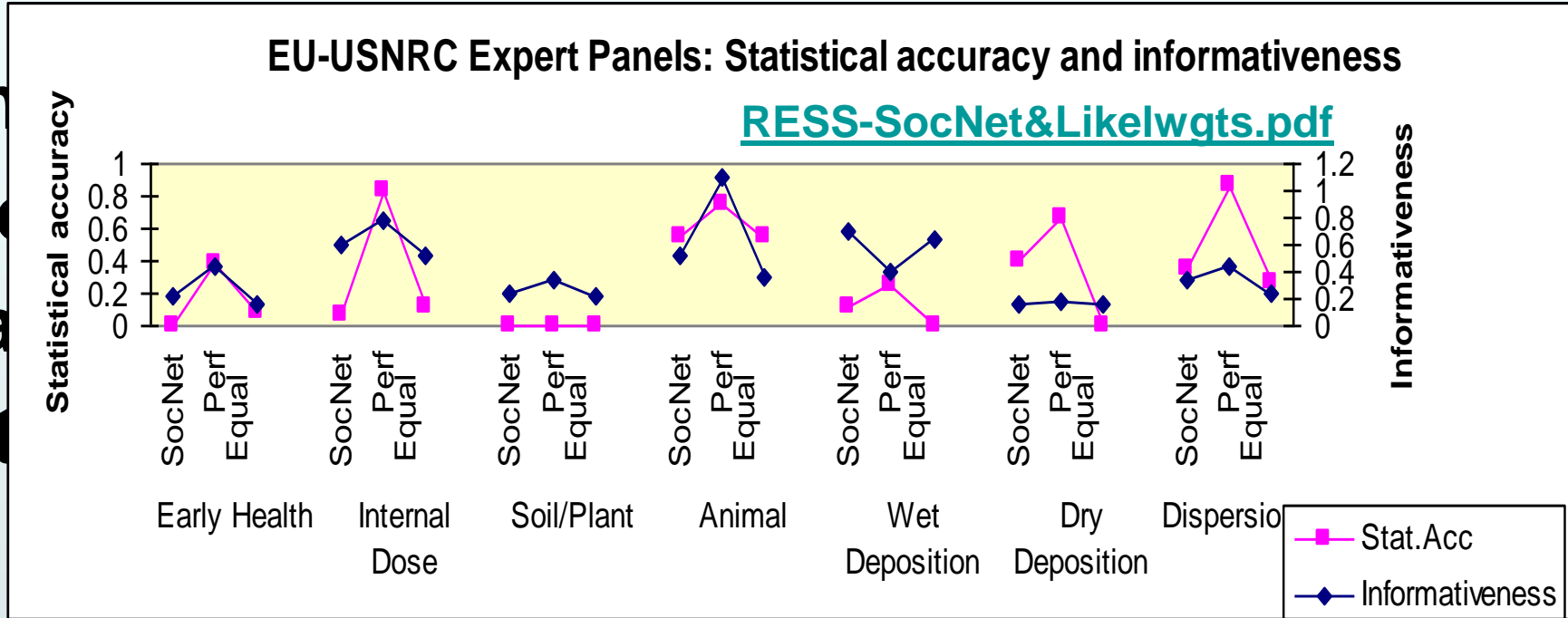


# 2. Experts CAN quantify uncertainty as subjective probability



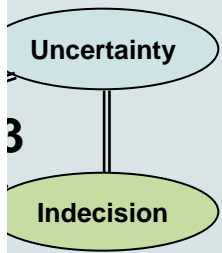
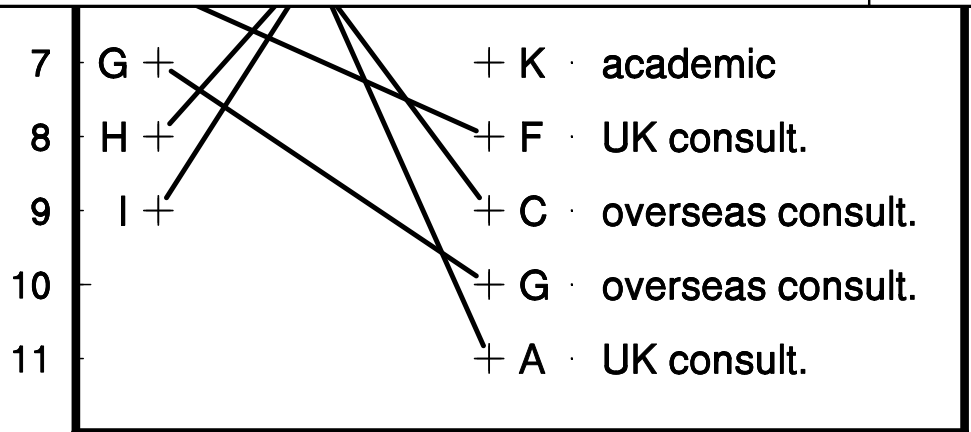
<i>TU DELFT Expert Judgment database 45 applications (anno 2005):</i>	# experts	# variables	# elicitations
Nuclear applications	98	2,203	20,461
Chemical & gas industry	56	403	4,491
Groundwater / water pollution / dike ring / barriers	49	212	3,714
Aerospace sector / space debris /aviation	51	161	1,149
Occupational sector: ladders / buildings (thermal physics)	13	70	800
Health: bovine / chicken ( <i>Campylobacter</i> ) / SARS	46	240	2,979
Banking: options / rent / operational risk	24	119	4,328
Volcanoes / dams	231	673	29079
Rest group	19	56	762
<b><i>TOTAL</i></b>	<b>587</b>	<b>4137</b>	<b>67001</b>

# 3. ALWAYS MEASURE PERFORMANCE !!!



Con  
Blu  
Cita  
Stat

do NOT predict performance





# 4. Experts like performance assessment



“ In the first few weeks of the Montserrat crisis there was perhaps, at times, some unwarranted scientific dogmatism about what might or might not happen at the volcano, .... The result was a dip in the confidence of the authorities in the Montserrat Volcano Observatory team and, with it, some loss of public credibility; this was not fully restored until later, when a consensual approach was achieved. “

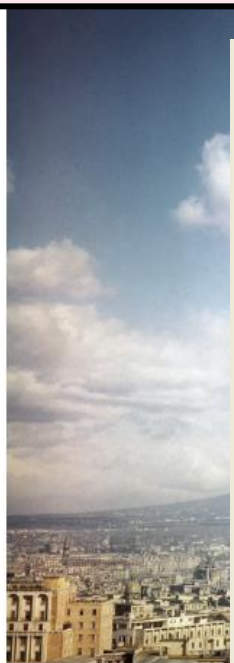
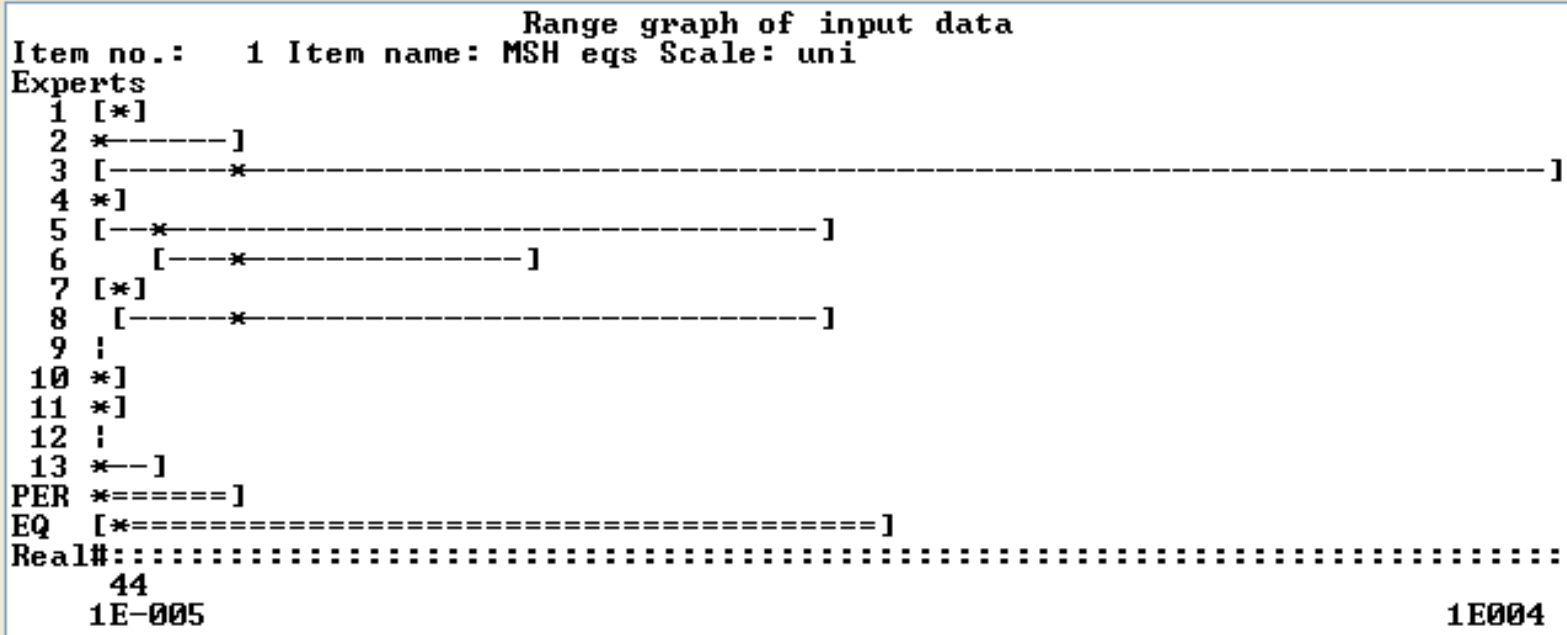
[Aspinall et al The Montserrat Volcano Observatory: its evolution, organization, rôle and activities.](#)  
ALSO: [Aspinall mvo exerpts.pdf](#), [Aspinall et al Geol Soc .pdf](#) , [Aspinall & Cooke PSAM4 3-9.pdf](#), [SparksAspinall VolcanicActivity.pdf](#)

**“The goal should be to quantify uncertainty, not to remove it from the decision process”** ([Aspinall Nature 21 Jan. 2010](#))

# 5. Simple averaging is not state-of-art

## Sheep Scab

Id	Calibr.	Mean relative	Mean relative	Numb	UnNormalized
		total	total	total	total



Vesuvius last awoke with a small b

EUROPE

MR	0.00131	1.75	3.617	10	0
GM	0.006287	1.242	3.783	10	0
PERF DM	0.4735	0.9048	2.02	10	0.9564
EQ DM	0.4735	0.5334	1.342	10	0.6354

Vesuvius is one of the most dangerous volcanoes in the world and the civil authorities can't agree on how to prepare for a future eruption.

It starts with a blast so strong that a column of ash and stone rockets 40 kilometres up into the stratosphere. The debris then drops to Earth, pelting the surface with boiling hot fragments of pumice and covering the ground with a thick layer of ash. Roofs crumble and chimneys fall. The ash is so fine that it will

BY KATHERINE BARNES

small eruption in 1944, but recent studies suggest that Vesuvius could be more dangerous than previously assumed, which has prompted a vigorous debate about the risk and scale of future eruptions. The eruption of 1944 was

interpret this layer as an active magma reservoir, which could lead to a 'plinian'-style explosion. The late 19th-century geologist Henry De la Beche, who described the 1873 eruption, said that the 1944 eruption was 'the first rumblings of activity at Vesuvius could come weeks to years before an eruption, but it is likely that if it occurs, it will be a

Nature, 12 May 2011

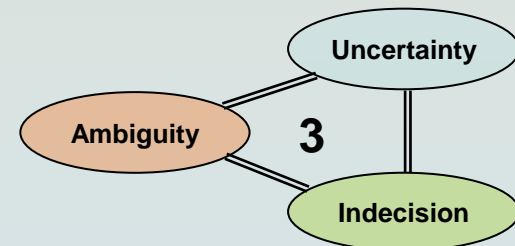
ENCES: 0: volcano; GEOTHEM: RES: 128: 273-285.

**The choice is NOT whether to use  
EJ;**

**but:**

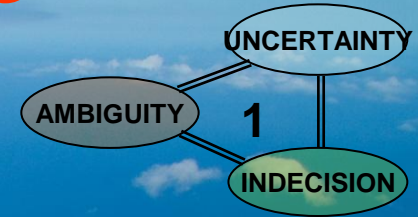
**do it well or do it badly?**

**Thanks for Attending**

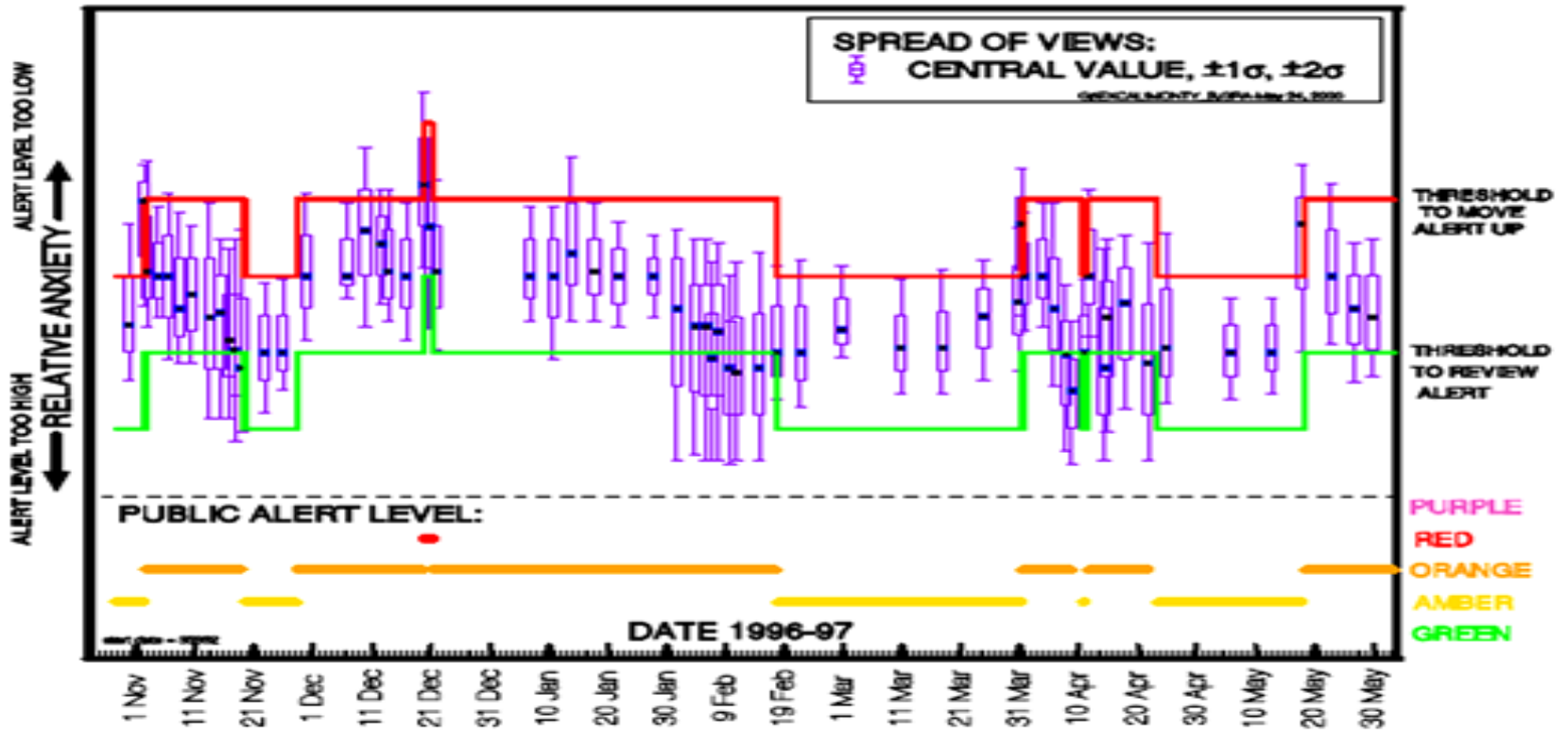


# Using Uncertainty to Manage Vulcano risk response

[Aspinall et al Geol Soc .pdf](#)



## MONTSERRAT VOLCANO: ALERT LEVEL ELICITATIONS



# 5. Simple averaging is not state-of-art

## Sheep Scab



Nr.	Id	Calibr.	Mean relative total	Mean relative realization	Number real
1	1	3.114E-005	2.227	2.227	15
2	2	0.001662	2.263	2.263	15
3	3	1.599E-010	2.642	2.642	15
4	4	0.03901	1.452	1.452	15
5	5	5.864E-009	2.196	2.196	15
6	6	0.6434	1.31	1.31	15
7	7	0.002273	2.02	2.02	15
8	8	2.699E-006	1.958	1.958	15
9	9	0.000393	2.275	2.275	15
10	10	0.04847	1.926	1.926	15
11	11	1.617E-011	2.308	2.308	15
12	12	6.35E-005	1.775	1.775	15
13	13	0.04847	1.766	1.766	15
14	14	0.006486	2.368	2.368	15
15	perf dm	0.6434	1.31	1.31	15
16	eq wgt	0.661	0.7799	0.7799	15

Item no.: 5 Average Flock Size

Experts

```

1 *)
2     [*-]
3     [-----*----]
4  [-*--]
5                                     [-----*-----]
6  [-----*-----]
7  [*]
8  [-----*-----]
9  [-*-----]
10     [---*-----]
11     [---*-----]
12  [-*-----]
13     [---*-----]
14  [-*-----]
Perf [====*====]
eq  [-----*-----]
Real:#####:

```

WSJ 5/31/2011  
**Chronic-Fatigue Paper Called Into Question**

By Amy Dockser Marcus

Editors of the journal Science have asked the co-authors of a 2009 paper that linked chronic fatigue syndrome to a retrovirus called XMRV to voluntarily retract the paper.

But in written response Friday, study co-author Judy A. Mikovits of the Whittemore Peterson Institute for Neuro-Immune Disease said "it is premature to retract our paper." The letter was reviewed by The Wall Street Journal.

The study raised patients' hopes that if a virus was linked to chronic fatigue syndrome, a treatment might be found. Public-health officials were alarmed by the possibility that supposedly healthy people might unknowingly be infected with a contagious retrovirus. The federal government has an agency...

published studies showed that some anti-retrovirals approved for use in HIV might also be effective against XMRV. Some doctors began prescribing anti-retrovirals for chronic fatigue syndrome patients.

The concern about the blood supply led blood banks to bar patients with chronic fatigue syndrome from donating.

The Centers for Disease Control and Prevention, among other groups, published studies reporting they didn't find XMRV in chronic fatigue syndrome patients. Other papers found that substances used as part of the process to detect XMRV might be contaminated, raising the possibility that this may explain the positive findings in the 2009 Science paper.

In the letter to the study authors, Dr. Alberts and Ms. Bradford suggested the paper be

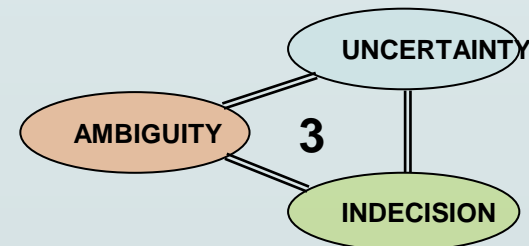
Nr.	Id	Calibr.	Mean relative total	Mean relative realization	Numb real
1	1	0.1005	1.883	1.12	15
2	2	0.1566	1.334	0.9977	15
3	3	2.248E-005	1.293	1.534	15
4	4	0.3297	0.985	1.384	15
5	5	0.0004915	1.452	1.466	15
6	6	0.8334	1.087	1.406	15
7	7	0.01751	0.8029	0.8445	15
8	8	0.3297	1.912	1.985	15
9	9	0.4311	1.211	0.9194	15
10	10	0.02961	1.385	1.274	15
11	11	0.0002843	1.298	1.091	15
12	12	0.571	1.238	1.539	15
13	13	8.906E-006	1.837	1.989	15
14	14	1.237E-005	1.422	2.787	15
15	g	0.8334	1.087	1.406	15
16	eq	0.3578	0.3238	0.3158	15

0.0001  
 Item no.: 45 Item name: I27 Scale: UNI  
 Experts

1	[-----*-----]
2	[-----*-----]
3	[-----*-----]
4	[-----*-----]
5	[-----*-----]
6	[-----*-----]
7	[-----*-----]
8	[-----*-----]
9	[-----*-----]
10	[-----*-----]
11	[-----*-----]
12	[-----*-----]
13	[-----*-----]
14	[-----*-----]
g	[=====*=====]
eq	[=====*=====]

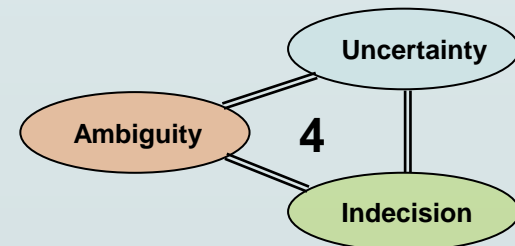
# Practical issues

1. The seed variables should sufficiently cover the case structures for elicitation..
2. For each panel at least 10 seed variables are needed, preferably more.
3. Expert names and qualifications published, but not associated with assessments.



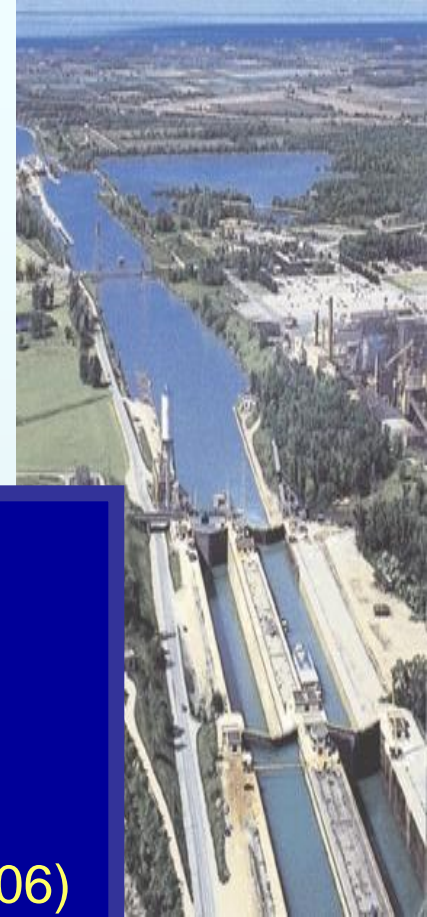
# Preparation of Elicitation Protocol

- [ElicitationProtocol\\_PM2.5.doc](#)
- [ElicitationProtocol\\_INVASIVE\\_SPECIES.doc](#)
- [NUREGCR-6545-Earlyhealth-VOL2.pdf](#)
- [Aspinall Briefing Notes.pdf](#)

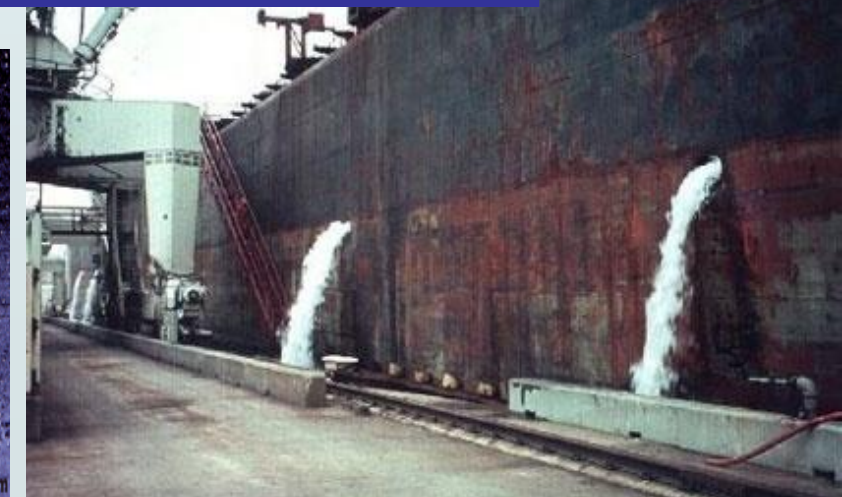








68% of 84 NIS established since 1959 associated with transoceanic shipping (Ricciardi 2006)



©Shedd Aquarium

New computer study shows widespread devastation in final phase of eruption

5mins after it begins

Column of red-hot ash, gas and rock collapses on to mountain, blasting towards populated areas

Magma erupts into the sky at 400mph

15mins

Pyroclastic flow sweeps through homes built illegally on slopes

Magma travels at 60 mph

Up to 300,000 could be killed

20mins

Flows burst through towns from shatterlines to Pompeii

"Today people aren't prepared for an evacuation. It's wrong to bet on carrying out the entire evacuation in just three or five days. If there was an eruption tomorrow it's quite possible we'd see huge traffic jams, car crashes and people using gas to make their

escape," he said. "We need a plan to start the evacuation of vulnerable people, like pensioners, fast. People need to know what to do and they have to understand they won't be able to get out by car. You can walk 10

miles in a good s... Some Vesuvius who believe a growth spurt for crowd-p

# Vesuvius blast could kill 300,000

■ John Follain

THE next eruption of Vesuvius could kill at least 300,000 people, nearly 20 times as many as the AD79 disaster that buried the ancient city of Pompeii, according to Italian government research.

More than half a million people live in the so-called "red zone" of 18 towns in a four-mile radius of the volcano and most would die if an evacuation could not be completed in time, the research says.

The findings are from a study by some of Europe's leading volcanologists and public health experts, including Dr Peter Baxter of Cambridge University's Department of Public Health.

Baxter began in the field as



The destruction of Pompeii, the worst affected city, has inspired many books and films, including Robert Harris's 2005 bestseller, which features Pliny the Elder and which is to be adapted by the director Roman Polanski in a £100m movie.

Some 2.5m tourists visited Pompeii last year, where the

people by bus from each of the 18 towns.

Professor Giuseppe Luongo of the University of Naples, a former director of the Vesuvius Observatory which monitors the volcano, believes plans are inadequate and local people are ill-informed about them.

