The Food & Environment Research Agency

Applying structured expert judgment: experience from projects on food safety and emerging sciences and technologies

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COST conference

2nd – 4th April 2014

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Outline of today's presentation

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- Interesting areas (e.g. stakeholder interest; health risks associated) where many uncertainties burden the system
  - Finished projects
  - On-going projects
- Methods that would enable decision making in view of uncertainties
- Challenges
  - Risk analysts
  - Policy makers

Uncertainty in Risk Assessment

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- "**Holy grail**" for evidence based decision making
  - Characterisation of uncertainties
    - What is unknown?
  - Impact on outputs
    - How much each of unknowns would affect the outcome or RA?
  - Communication of uncertainties
    - All involved should be aware of unknowns and their impact

Uncertainty in ↑ Assessment Benefit; Risk/Benefit

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Uncertainty in Risk Assessment

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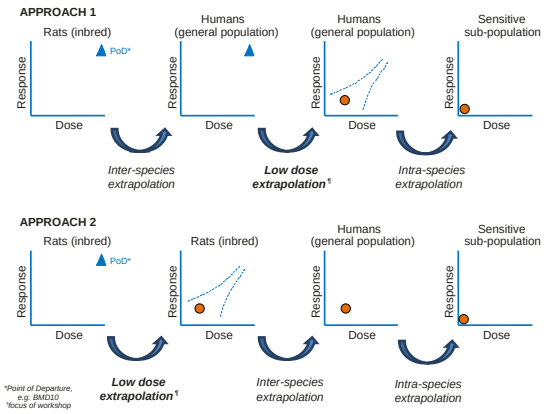

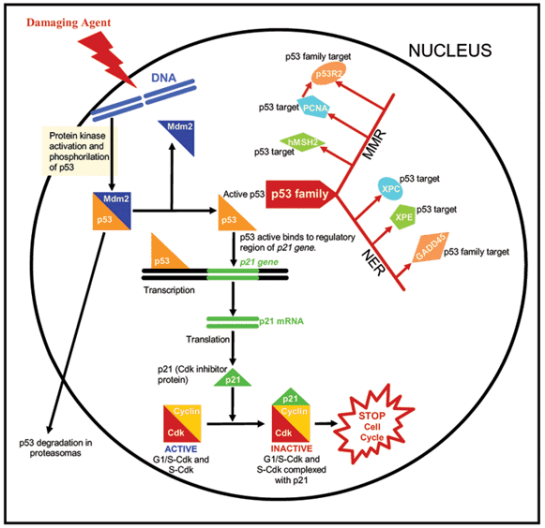

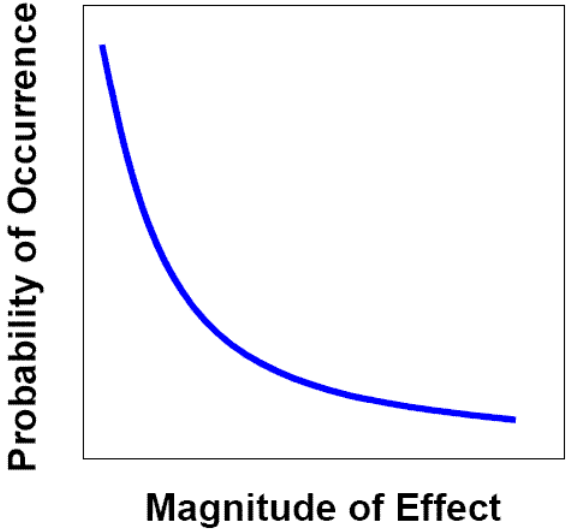

Uncertainty factors

Worst case scenarios

Probabilistic risk assessment

Conservative – obstacle for novel products/technologies

Data hungry

Decision making

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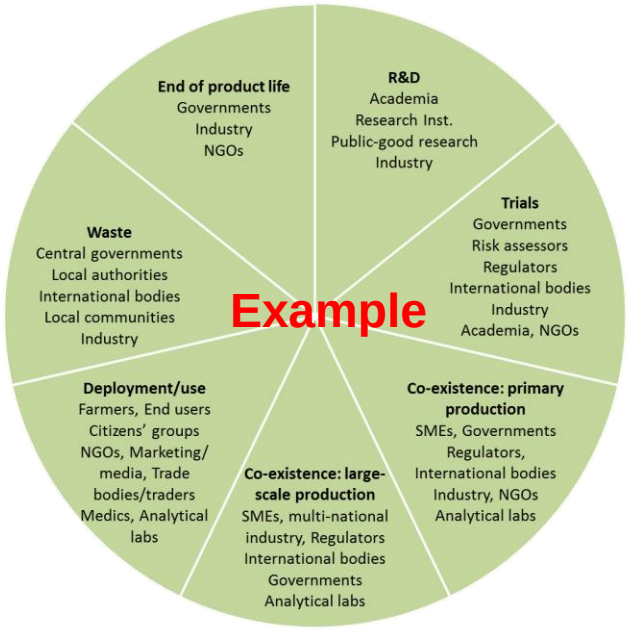
Undisputable elements

- Optimum
- Evidence based
- Transparent
- Effortlessly communicated
- Participatory approaches



Decision Making under uncertainty

The need to address these elements is even bigger

Multiple risks

Nanotechnologies
Numerous potential benefits

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- Less use of chemicals (e.g. catalysts, paints & coatings)
- Novel functional materials (e.g. packaging, construction)
- Healthy food products (e.g. less use of fat, salt, preservatives);
- Longer shelf-life of foodstuffs;
- Improved health and wellbeing (greater bioavailability of nutrients & supplements)
- Nano(bio)sensors for diagnostics and monitoring
- Cleanup of contaminated environments
- Water desalination and decontamination

Participants in this work

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- Rabin Neslo
- Roger Cooke
- Qasim Chaudhry
- Experts for the building of the model (n=21)
- Experts for the external validation (n=31)
  - Overlap between these groups (n=10)

Multi Criteria Decision Model Expert Judgment protocol

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The method models **expert knowledge (rankings)** by employing probabilistic inversion.

(in our case 21 **experts** on **nanotechnology research in the food sector**)

STEP 3: IDENTIFY & RECRUIT EXPERTS

(in our case **rankings** on 26 **hypothetical nanotechnology-enabled food products**)

STEP 4: ELICITATION

These **hypothetical nanotechnology-enabled food products** are **precisely defined** (by us) via a number of **criteria** or attributes.

STEP 2: SCENARIOS

In our case these **criteria** are a number of **attributes** that are considered as **significant** in order to **assess/evaluate potential risk considerations** of **nanotechnology-enabled food products**.

STEP 1: CRITERIA

Multi Criteria Decision Model Criteria

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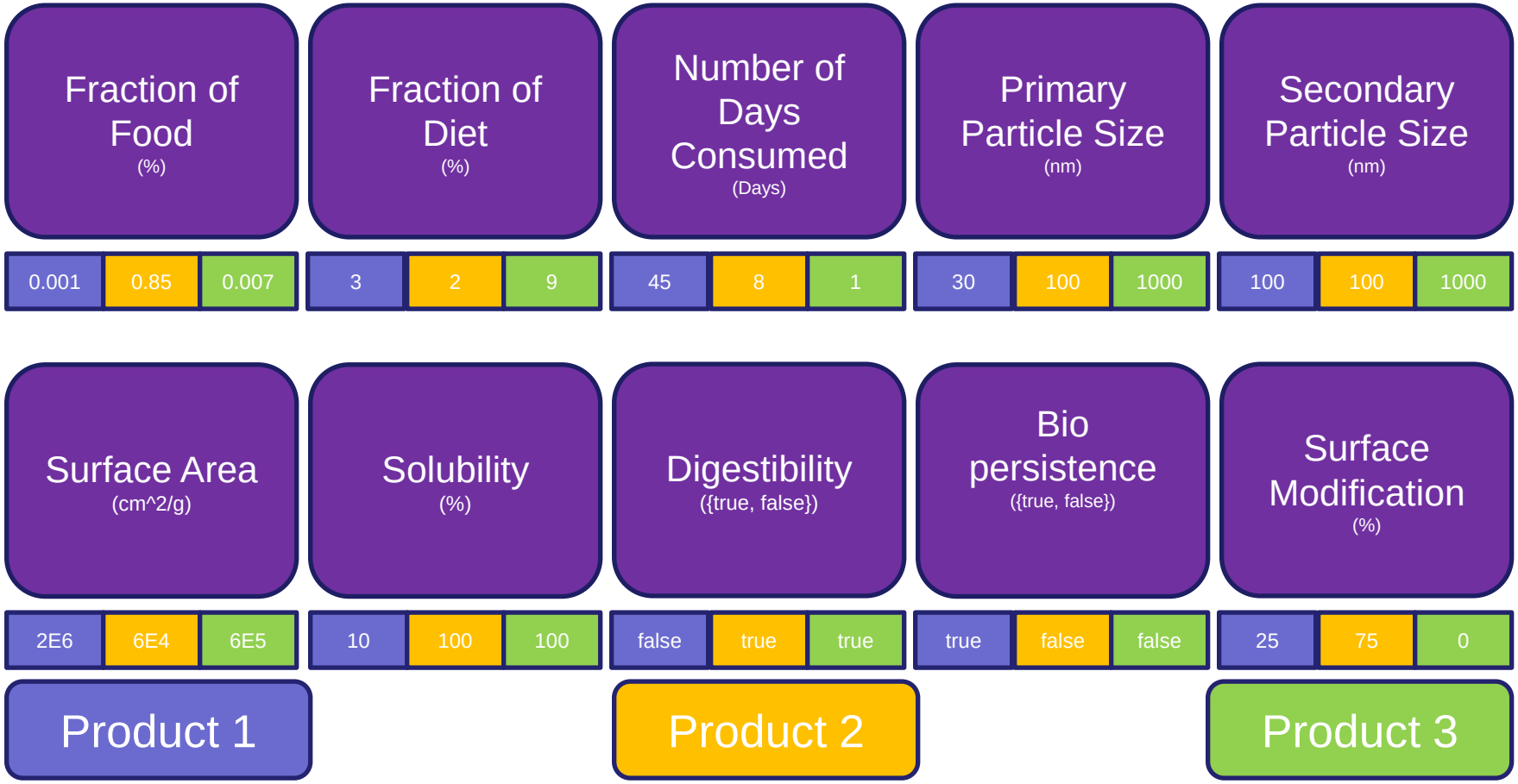

Multi Criteria Decision Model Scores – decision making

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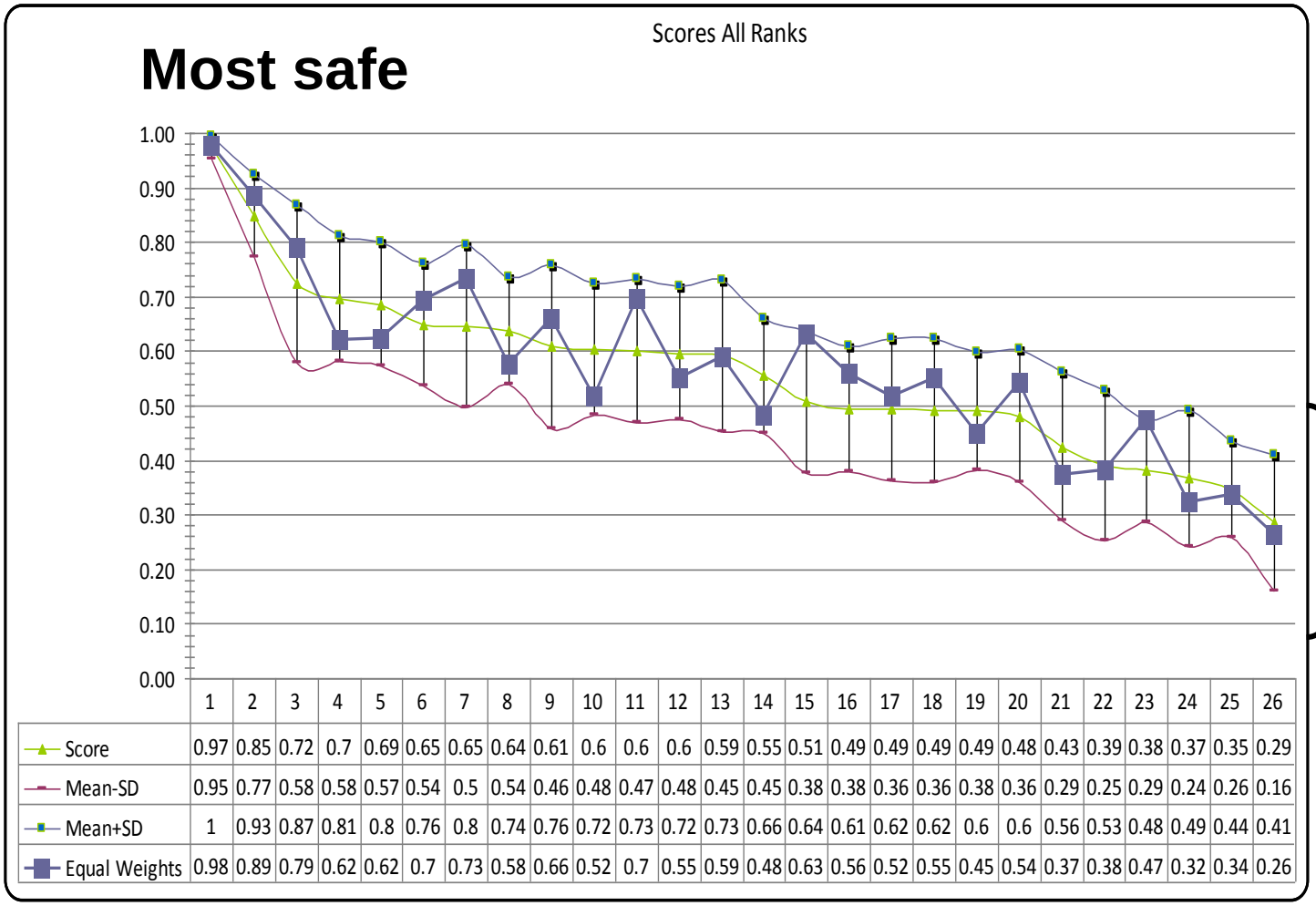

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Score	0.97	0.85	0.72	0.7	0.69	0.65	0.65	0.64	0.61	0.6	0.6	0.6	0.59	0.55	0.51	0.49	0.49	0.49	0.49	0.48	0.43	0.39	0.38	0.37	0.35	0.29
Mean-SD	0.95	0.77	0.58	0.58	0.57	0.54	0.5	0.54	0.46	0.48	0.47	0.48	0.45	0.45	0.38	0.38	0.36	0.36	0.38	0.36	0.29	0.25	0.29	0.24	0.26	0.16
Mean+SD	1	0.93	0.87	0.81	0.8	0.76	0.8	0.74	0.76	0.72	0.73	0.72	0.73	0.66	0.64	0.61	0.62	0.62	0.6	0.6	0.56	0.53	0.48	0.49	0.44	0.41
Equal Weights	0.98	0.89	0.79	0.62	0.62	0.7	0.73	0.58	0.66	0.52	0.7	0.55	0.59	0.48	0.63	0.56	0.52	0.55	0.45	0.54	0.37	0.38	0.47	0.32	0.34	0.26

Experts' variability

→Scenarios

Multi Criteria Decision Model Validation (within dataset: internal)

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- Checks if experts' ranks are recovered from the distribution over weights
- Splits experts' ranks in a training set and a validation set
- Solves model using training set
- Tries to recover ranks in the validation set

Criteria employed

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- **Adequacy**: Will the option deliver enough to ensure health and environmental safety?
- **Cost**: How much would the implementation of the option cost?
- **Efficiency** – enforcement: Is the option efficient in ensuring compliance?
- **Liability**: How reliable is the option in terms of identifying and monitoring its failures?
- **Public trust and transparency**: Would the option be perceived as trustworthy and transparent from the public?
- **Relevance**: What proportion of nanotechnology enabled consumer products does this option cover?

Validation (external) → predictive value

		Score calculated by fitting the model on:							
		Potentially safe rankings		Potentially unsafe rankings		All rankings (potentially safe + potentially unsafe)		All ranks assuming equal weights for criteria	Ranking of products in terms of their safety by experts in breakout groups
		All	Most common (>0.1)	All	Most common (>0.1)	All	Most common (>0.1)		
Group 1	P1								1
	P2								2
	P3								3
	P4								4
Group 2	P1								3
	P2								1
	P3								2
	P4								4
	P5								5
Group 3	P1								2
	P2								3
	P3								1

Pair wise comparisons
Decision on regulatory options

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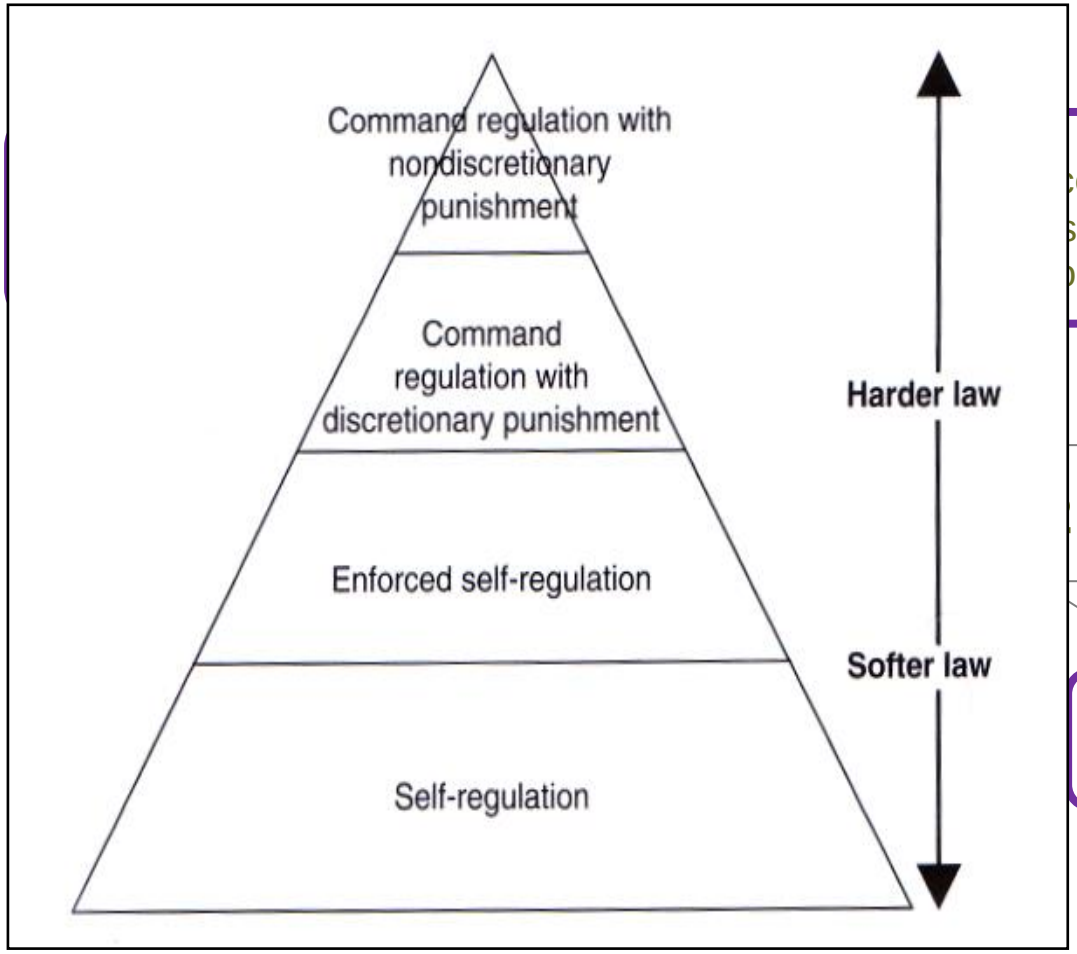

ced sight by orities

O6 Enforced regulatory framework by international authorities

+ O6

O7

O4 + O6

O8

Definitions

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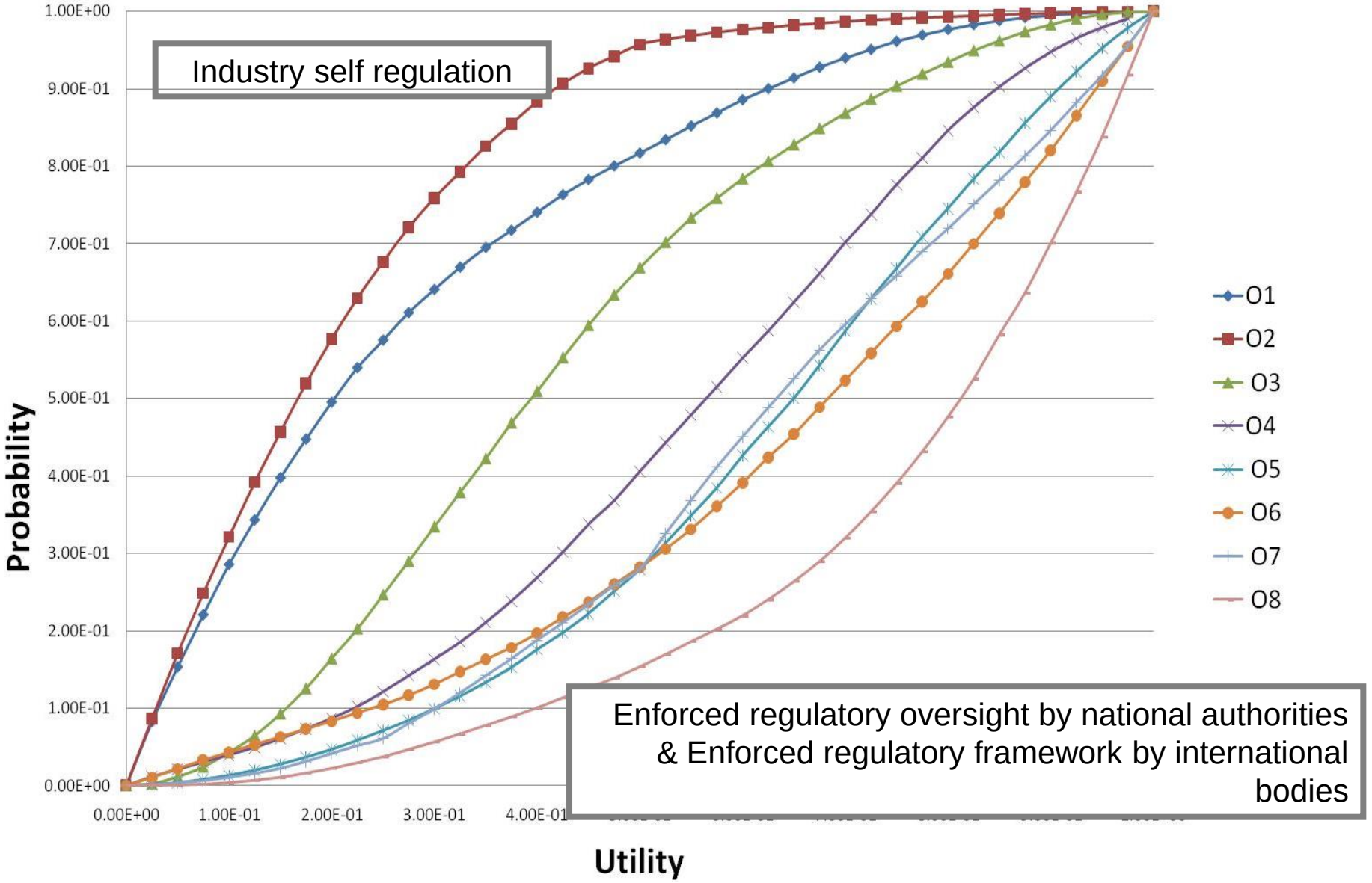
- O1 Industry code of conduct, product stewardship: defined as **programmes to improve performance**, sponsored by trade/industry organisations

- O2 Industry self-regulation: defined as alternate (industry) compliance plans

Pair wise comparisons – regulatory options



Challenges

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- Useful, meaningful method
- And yet, a lot of reluctance from policy makers to apply it in more areas
  - Complicated
  - Preference for methods that are deemed as quicker
    - E.g. scoring on arbitrary scales

On-going research for MCDM

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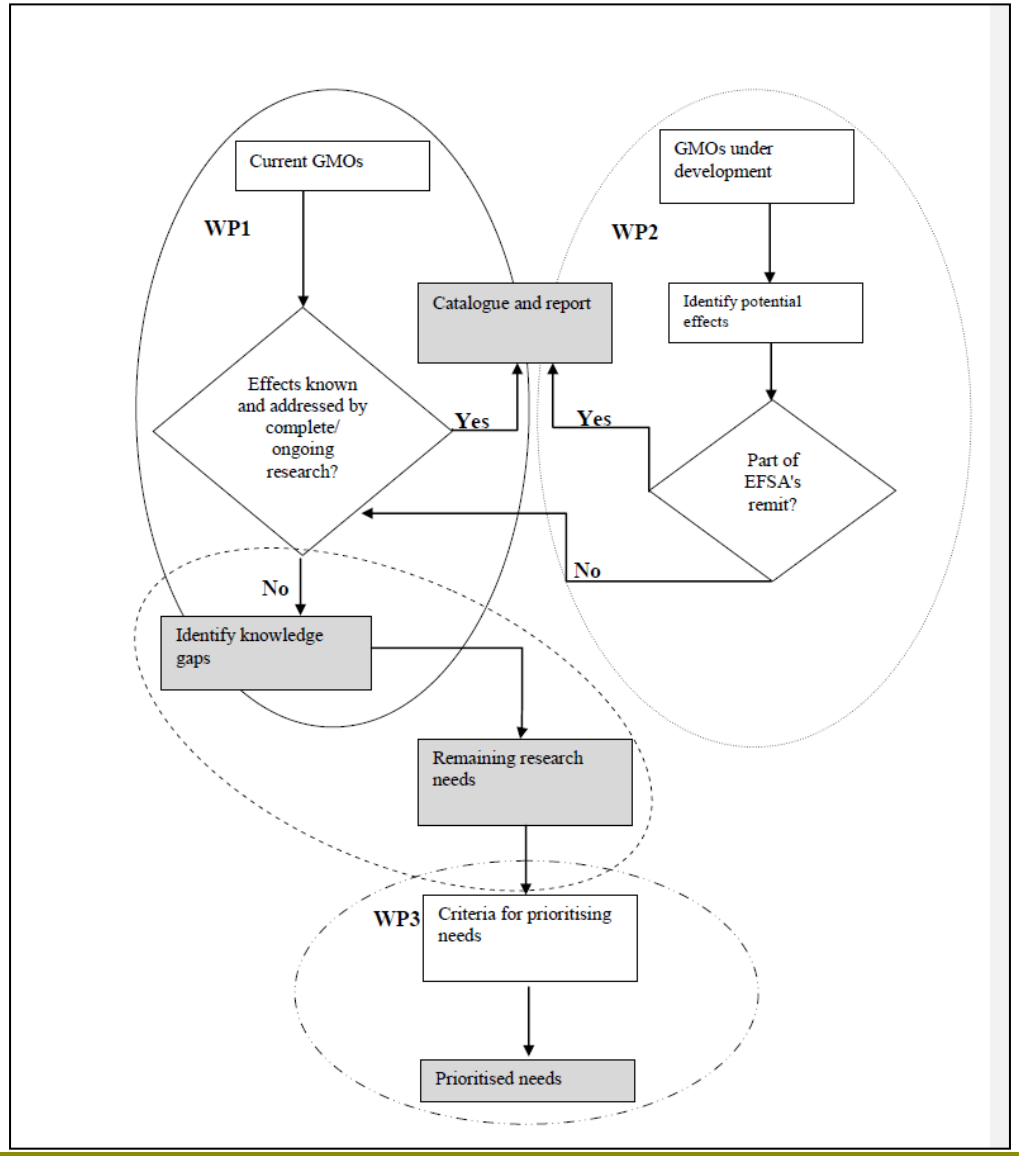


CSA EU "PreSTO"

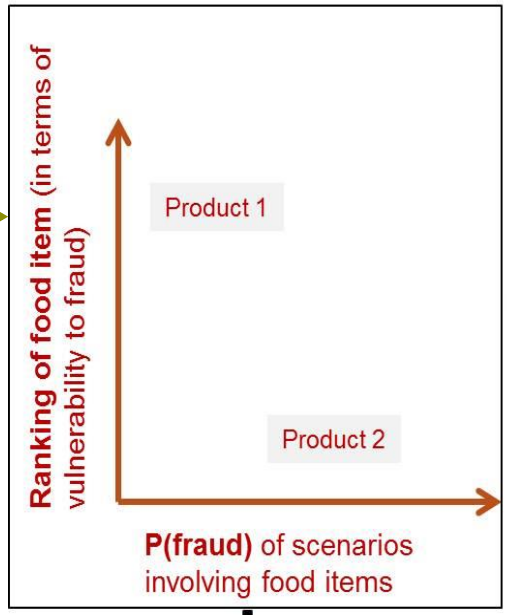
GMOs ERANET

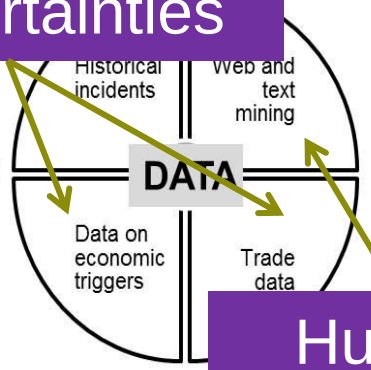
Early warning system in food fraud EU FP7

MCDM models, BBNs human intelligence

Estimates of unknown parameters and of uncertainties

WP8

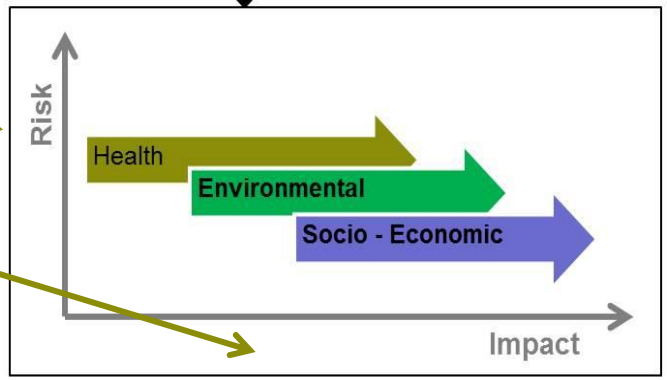




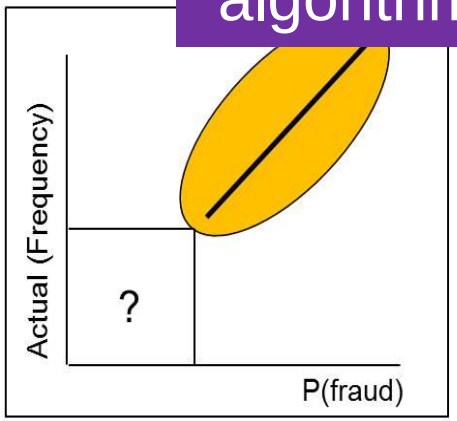
Human intelligence on algorithms

Probabilities of adverse effects

Act or not?



Estimates of impacts



Feedback between detection & p(fraud) → Validation

P(fraud) → Scenarios

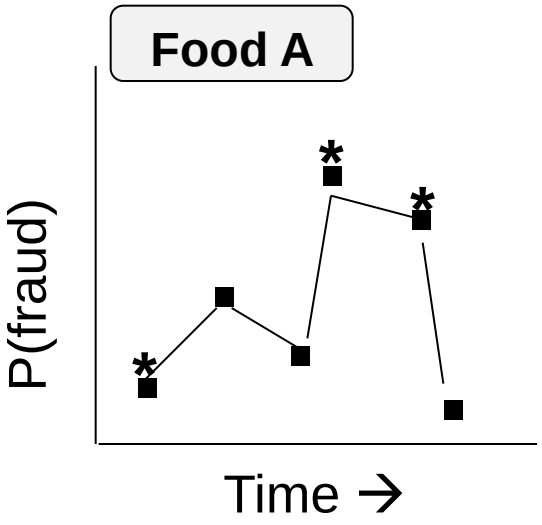
Defined conditions

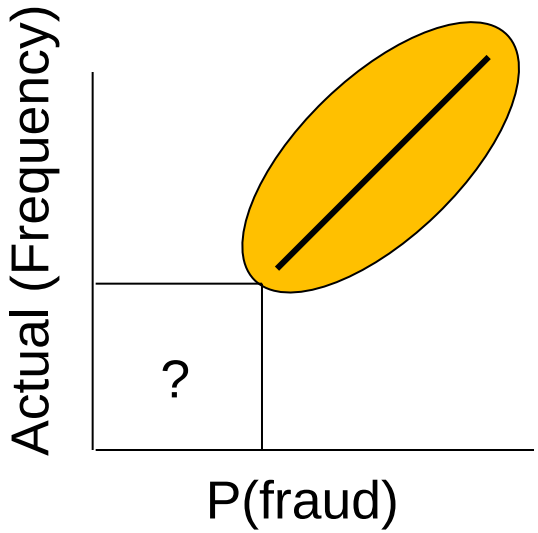
Fraud detected?

Yes *

No

Surveillance / Monitoring actual frauds





How good we are? The closest to the line the better the prediction system developed

In time it would help experts to improve their judgments

RA of genotoxic carcinogens – extrapolation to human-relevant exposures

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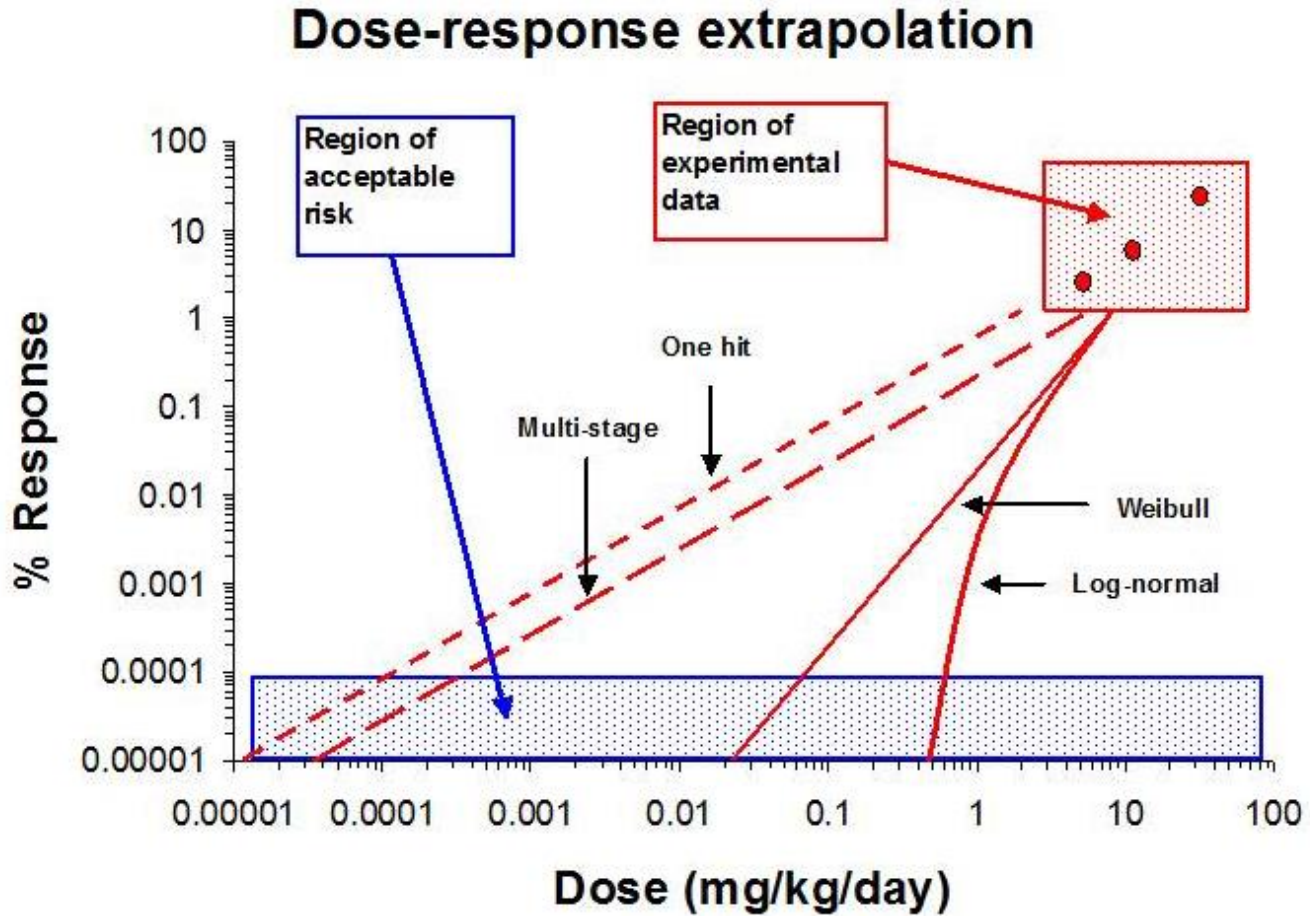

Participants in this work

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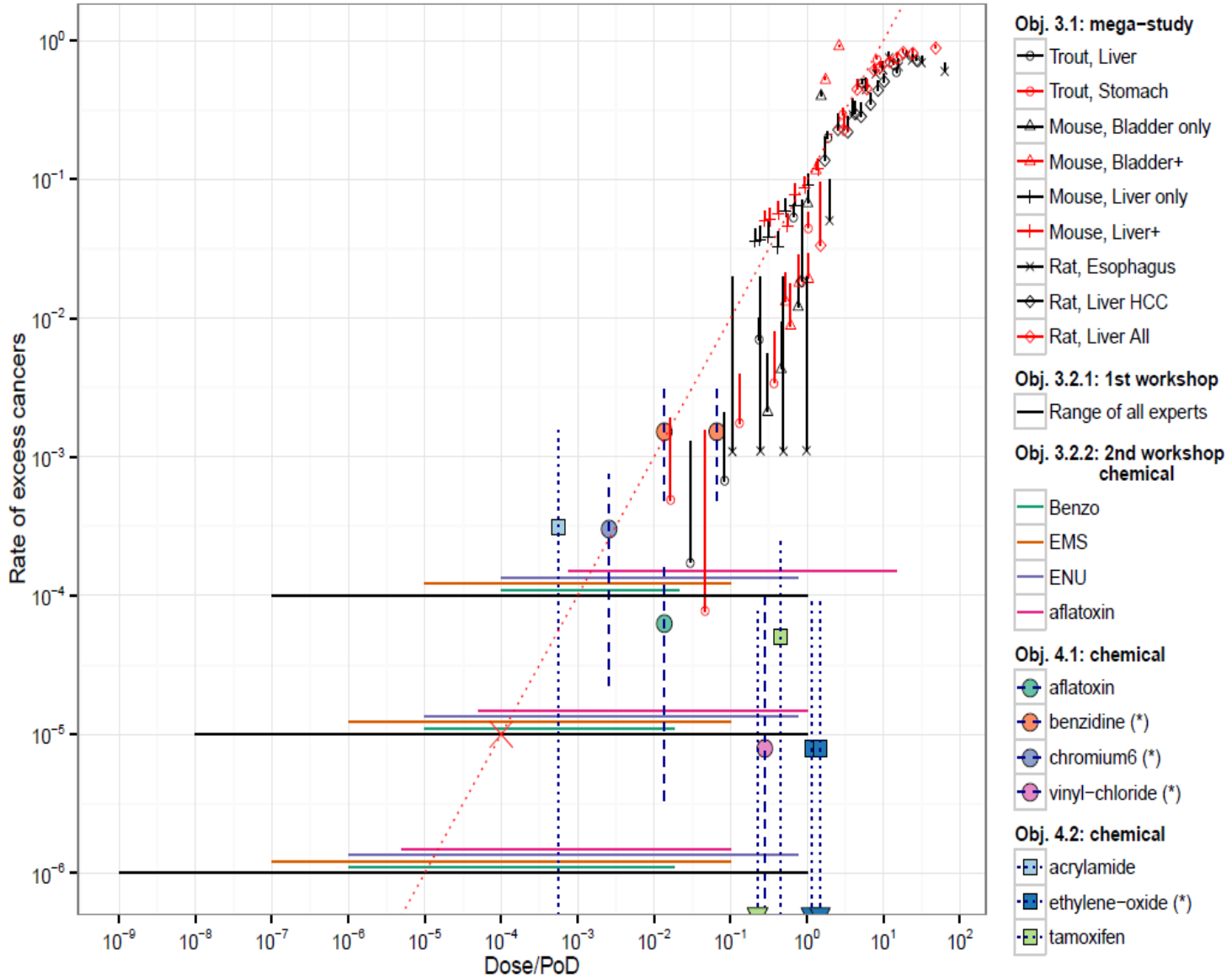
- Alan Boobis
- Peter Craig
- JP Gosling
- Andy Hart
- Lesley Rushton

Genotoxic carcinogens - integration of all information – can EJ help deciding?



Acknowledgments

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- Colleagues
  - Paul Brereton, Alan Boobis, Qasim Chaudhry, Roger Cooke, Andy Hart, Rabin Neslo
- All experts
  - Responders in consultation exercises (Jan/Feb 2011)
  - Participants in experts' workshops (Sep/Oct 2011; May 2011; Sep/Oct 2012; March 2013)

Q & A session

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Thank you for your attention!

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Working Group 4

Technical and commercial applications and knowledge exchange

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COST conference

2nd – 4th April 2014

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Ultimate aims

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- Contribute in setting good standards in applying expert judgment
- Increase the breadth of applications in the public and private sectors
- Contribute in setting up a "*Centre of Excellence*" in the area of expert judgment

Tasks to achieve aims

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- **T1** Comprehensive overview of past and on-going applications
  - **Matrix** approach to summarise which / where / how
  - ➢ Dimensions of matrix – areas & methods
  - ➢ Methods to identify information
  - ➢ Division of work in different areas and/or different methodologies

	Probabilistic estimates	Preferences	Correlations	Probabilities	Other
COST domains Other?					

Tasks to achieve aims

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- **T2** Evaluation of past and on-going applications to identify "*degree of maturity*" in different areas
  - **Maturity index**: degree of impact on policy making and decision making; "how close" to being the "norm" practice in this area
    - Components of index
  - Division of work (similar to T1 or less people involved?)
  - Update and maintenance of this overview

	Probabilistic estimates	Preferences	Correlations	Probabilities	Other
COST domains Other?					

Tasks to achieve aims

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- **T3** Knowledge exchange amongst different sectors with different degree of maturity
  - Bringing together researchers from “mature” and “non mature” areas
    - Planned workshops
    - End-users / stakeholders meetings: small audience; targeted participants
    - ESF workshop (any area) and/or Gordon conference (any area?)
  - Division of work – lead per workshop/meeting/proposal
    - Organisation / Report

WG4 Participants

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The more the merrier ☺

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Rainer Göb			
Anca Hanea			
JC Komorowski			
Joanna Labedzka			
Augusto Neri			
David Rios			
Fabrizio Ruggeri			
Jim Smith			
Charles R Twardy			

Participant	T1	T2	T3