

#### European Risk Summit, 12th June 2013

Communicating and Assessing Risk in Uncertain / Emerging Areas of Science

**PROFESSOR MARK WJ FERGUSON** 

DIRECTOR GENERAL, SCIENCE FOUNDATION IRELAND & CHIEF SCIENTIFIC ADVISER TO THE GOVERNMENT OF IRELAND





# We live at a time when emotions and feelings count more than truth and there is a vast ignorance of science

James

Lovelock







- In common parlance "Scientific" synonymous with "Certain"
- In reality Science is hypotheses testing and experiments
- Incomplete, continually changing, i.e. all Science is contingent
- Advice and judgements occur when the Science is incomplete

## **Uncertainty**



- Scientists love it, Politicians hate it
- Reality is Perception
- Reduce as much as possible
- Indicate Consensus
- State Implications of Uncertainty
- Options for action rather than Golden Bullet



- What do we know?
- How and with confidence do we know it?
- What more do we need to know?
- How and when can we know it?
- What should we do and when should we do it?
- How best to communicate this?





- Pseudo uncertainty
- Variability
- Limitation of current scientific understanding
- Stochastic character of the underlying process

#### **Uncertainty Pitfalls**

![](_page_6_Picture_1.jpeg)

- Omission or understatement of uncertainties
- Exaggeration of uncertainties
- Inclusion of what is countable to the exclusion of what counts
- Failure to address the relevance or irrelevance of the uncertainties to the decision at hand
- Failure to address cost and timescale for reducing the uncertainties that matter most

#### **Best Practice**

![](_page_7_Picture_1.jpeg)

- Avoid illusionary precision use confidence bands and explain their basis
- Discuss the unquantifiable
- Identify and separate pseudo uncertainties
- Analyse and explain how the uncertainties matter or don't
- Be clear about the possibilities for reducing uncertainty with time

![](_page_8_Picture_0.jpeg)

# **All Uncertainty is Two Sided**

#### **Climate Change**

Less Disruptive and adverse to human well being than the current consensus

BUT it could by

MORE disruptive and adverse

### **Burden of Proof**

![](_page_9_Picture_1.jpeg)

- All Science is contingent
- Greater the consistency and coherence of the evidence and analysis, the lower the likelihood that the principal conclusions derived from it will be overturned
- Issue of the single contradictory piece
  - Not yet scrutinised / repeated
  - How science works
  - Usually a mistake
  - Few scientific revolutions

![](_page_9_Figure_9.jpeg)

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# Policymakers are gambling against very big odds if they bet that the mainstream scientific position is wrong.

![](_page_10_Picture_2.jpeg)

![](_page_11_Picture_0.jpeg)

- Describe the weight of evidence for any view
- Use plain language
- Describe what is known and what is not known
- Put probabilities into an everyday context
- Highlight areas of controversy
- Indicate areas of concern / vested interest
- Describe the basis and limitations of predictions / modelling
- Don't cherry pick the data

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- Acute problems
  - Physical crises e.g. earthquake, volcanic eruption, industrial accident
  - Responsive marshalling of evidence
- Chronic problems
  - Cross departments, cross disciplines, long timescales
    e.g. obesity, mental health, climate change
  - Strategic long term advice

![](_page_13_Picture_0.jpeg)

# **Tools & Techniques**

- Foresight
- Horizon Scanning
- Scientific Advisory Group
- National Risk Register
- Departmental Scientific adviser networks
- National Academies
- International CSA network
- Open policymaking
- Integrated Risk Forecasts
- Transparency
- Global Risk Register

![](_page_13_Figure_13.jpeg)

# **Reducing Risks of Future Disasters**

- Foresight Project looks out to 2040
- Lead Expert Group of academic, industry and humanitarian experts
- Evidence base:
  - 18 independently peer reviewed papers
  - High level international stakeholder summit
  - Several expert workshops
- Final report peer reviewed by experts and stakeholders

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![](_page_14_Picture_9.jpeg)

# Science and disaster risk

- This framework is used in many sectors for addressing risk:
  - Identify risk
  - Decide how to respond to risk
  - Act to address risk
  - Monitor outcomes
- For disaster risk, science plays an important role at each stage

![](_page_15_Figure_7.jpeg)

Source: Foresight

Identifying and

measuring risk

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#### **Actions**

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- Transfer Risk
- Avoid Risk
- Reduce Risk
- Accept Risk

![](_page_16_Picture_6.jpeg)

# UK Government National Risk Register

![](_page_17_Picture_1.jpeg)

For a range of risks, assessment of

- Likelihood
- Potential impact
- Vulnerability

Inform anticipatory policies and contingency planning to build resilience

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# World Economic Forum Global Risks Annual Report

![](_page_18_Picture_2.jpeg)

#### **X Factors**

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- Low probability, high impact risks resulting from human activity
- Neuroscience cognitive enhancement
- Geo engineering
- Societal burden of disability and dementia
- Catastrophic climate feedback
- Alien life contact
- Synthetic biology

![](_page_19_Figure_9.jpeg)

![](_page_20_Picture_0.jpeg)

![](_page_20_Picture_1.jpeg)

- Rapid spread of uncontrollable and destructive information
- Like spreading rumours : 4 concepts
  - Motivation
  - Situation
  - Narrative context
  - Trust

![](_page_20_Figure_8.jpeg)

# Trust

![](_page_21_Picture_1.jpeg)

- Greater Trust
  - Dampens perceptions of threat
  - Makes negative rumours less believable
  - Enhances effectiveness of rumour refutation or response

![](_page_22_Picture_0.jpeg)

Under conditions of interdependence and equal status increased contact with members of rival groups decreases negative stereotyping and increases trust

**Challenge for digital world** 

![](_page_22_Picture_3.jpeg)

## **Natural Risks**

![](_page_23_Picture_1.jpeg)

- Super volcanos
- Asteroid / comet strike
- Y Ray bursts
- Epidemic: fungus, virus, bacteria
- Solar flare
- Sediment slip

![](_page_23_Figure_8.jpeg)

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- General
  - Slower return to equilibrium
  - Increased variance
- Specific Data and Modelling from Different Complex Systems
  - Remote sensing
  - Satellite images
  - Distributed sensors
  - Model and Predict
- Both theoretical and experimental approaches show the existence of measurable signs of impending transitions

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# **Systemic Risks & Complexity**

Many of the 21<sup>st</sup> Century systemic risks depend crucially on the often unanticipated consequences of interactions within and between different types of systems.

![](_page_25_Figure_3.jpeg)

## **Risk Ecosystems**

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- Interdependency and Interconnection
- Value of Diversity
- Sustainability
- Peripheral players often first to recover
- Mathematical and Computational Modelling
- Complex Systems: *Environmental, Financial, Urban, Societal, Health, Climate*

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#### Aggregative Contingent Estimation (ACE)

"The goal of the ACE Program is to dramatically enhance the accuracy, precision, and timeliness of intelligence forecasts for a broad range of event types, through the development of advanced techniques that elicit, weight, and combine the judgments of many intelligence analysts.

The ACE Program seeks technical innovations in the following areas: (a) efficient elicitation of probabilistic judgments, including conditional probabilities for contingent events; (b) mathematical aggregation of judgments by many individuals, based on factors that may include: past performance, expertise, cognitive style, metaknowledge, and other attributes predictive of accuracy; and (c) effective representation of aggregated probabilistic forecasts and their distributions. The ACE Program will build upon technical achievements of past research and on state-of-the-art systems used today for generating probabilistic forecasts from widely-dispersed experts. The program will involve empirical testing of forecasting accuracy against real events."

Source: http://www.iarpa.gov/solicitations\_ace.html

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#### **Open Source Indicators (OSI)**

"The OSI Program seeks to develop methods for continuous, automated analysis of publicly available data in order to anticipate and/or detect societal disruptions, such as political crises, disease outbreaks, economic instability, resource shortages, and natural disasters. The Program will aim to develop methods that 'beat the news' by fusing early indicators of events from multiple data sources and types."

Source: http://www.iarpa.gov/solicitations\_osi.html

![](_page_29_Picture_0.jpeg)

# New approaches to biological risk assessment

![](_page_29_Picture_2.jpeg)

Science Policy Centre INTERNATIONAL WORKSHOP

web royalsociety.org/policy

twenty ten 350 years of and beyond excellence in science

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# **Spectrum of Biological Risks**

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- Naturally occurring diseases
- Re-emerging infectious diseases
- Unintended consequences of research
- Laboratory Accidents
- Lack of Awareness
- Negligence
- Deliberate Misuse

# **Dual use Biological Research**

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- 7 general 'experiments of concern'
- How to:
  - Render a vaccine ineffective
  - Confer resistance to therapeutically useful antibiotic or antiviral agents
  - Enhance the virulence of a pathogen or render a non pathogen virulent
  - Increase transmissibility of a pathogen
  - Alter the host range of a pathogen
  - Enable the evasion of diagnostic / detection modalities
  - Enable the weaponization of a biological agent or toxin

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![](_page_32_Picture_1.jpeg)

Hazard v. Risk

- Agricultural Chemicals is it a carcinogen / endocrine disruptor etc.?
- Food & Drink coffee, sugar, salt

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#### Do nothing until all uncertainties have been resolved and all risks eliminated

• Recipe for stagnation – Sir Aaron Klug

Taking some risk is a necessary condition for progress

## **Justification of Risk**

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# Increased justification for risk demanded when those who create the risk and benefit from it, are not the same as those who bear the risk.

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- Uncontrollable
- Poorly understood
- Inequitable
- Intergenerational
- Irreversible
- Potentially catastrophic

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- Scientific Method
- Safe is a relative and subjective term
- Make value judgements by weighing advantages and disadvantages – not always logical e.g. smoking

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Affect:

- How receive information about risk
- How process the information
- How use it to make judgements

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## **Fright Factors**

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- Make people more wary of some risks than is warranted by objective calculation of the odds
- Risk less acceptable if the risk taker has no choice as to whether to take the risk and no personal means of managing it, e.g. smoking versus food product safety

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# **Resolution of Risk Issues**

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- Scientific research data, analysis and judgement
- Other judgements based on people's :
  - Attitudes
  - Values
  - Ethics
  - Religion

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- Comfortable as producers and users of Science and Technology
- Educated and have influence
- TRUST

![](_page_40_Picture_4.jpeg)

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![](_page_41_Picture_1.jpeg)

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Science Foundation Ireland