Proceedings of the EMII Connected Learning Risk Research Symposium III: Nuclear Incident (Abroad)

Edited By: McMullan, C., & Brown, G.D. 2018, DCU, Dublin, Ireland

10th May 2019

EMII

Setting the Scene Nuclear Incident Abroad: Expert and Public Perception

Prof Caroline McMullan, Gavin D. Brown & Dr Ann Largey

DCU Business School

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Nuclear Incident Abroad: Expert & Public Perception

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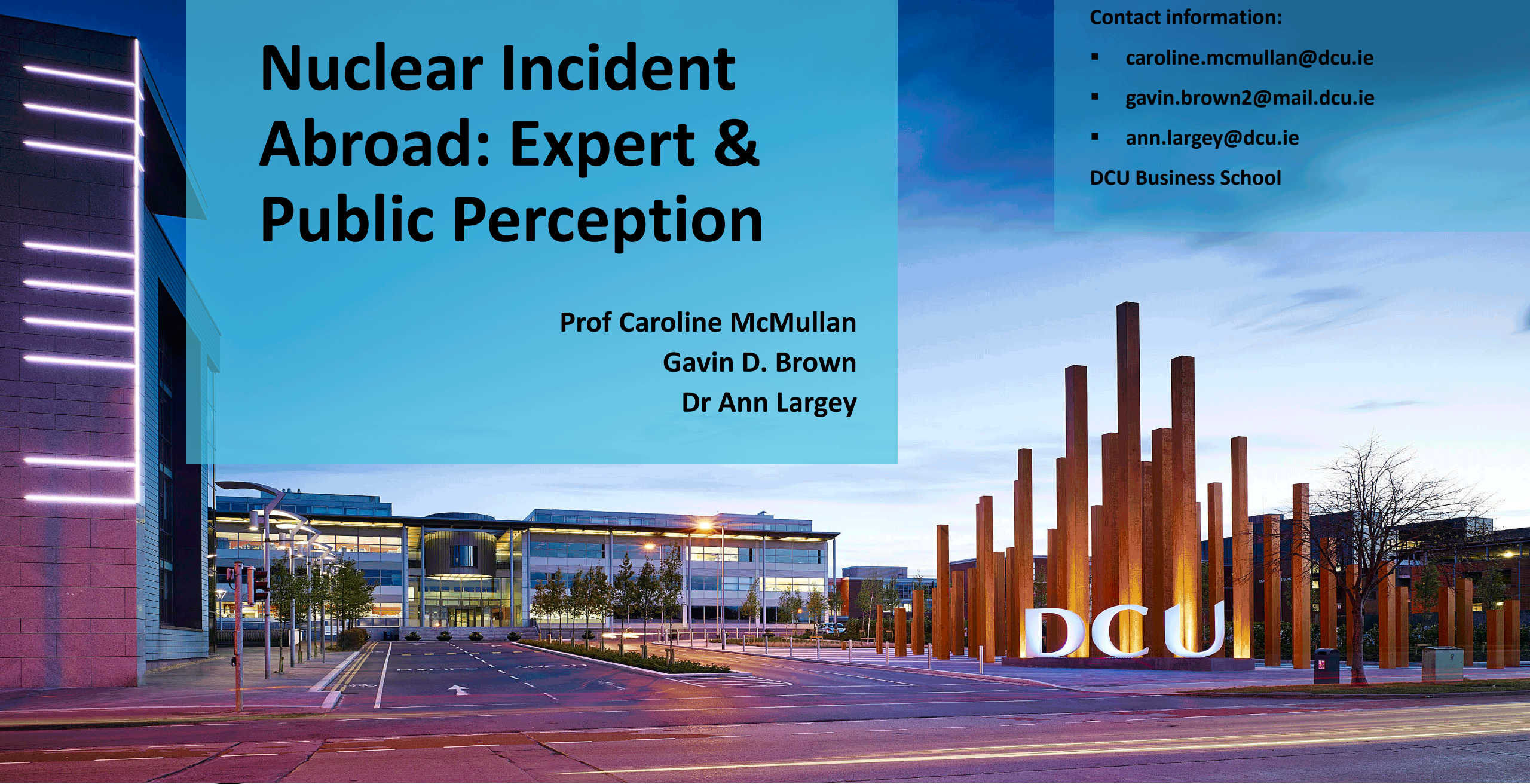

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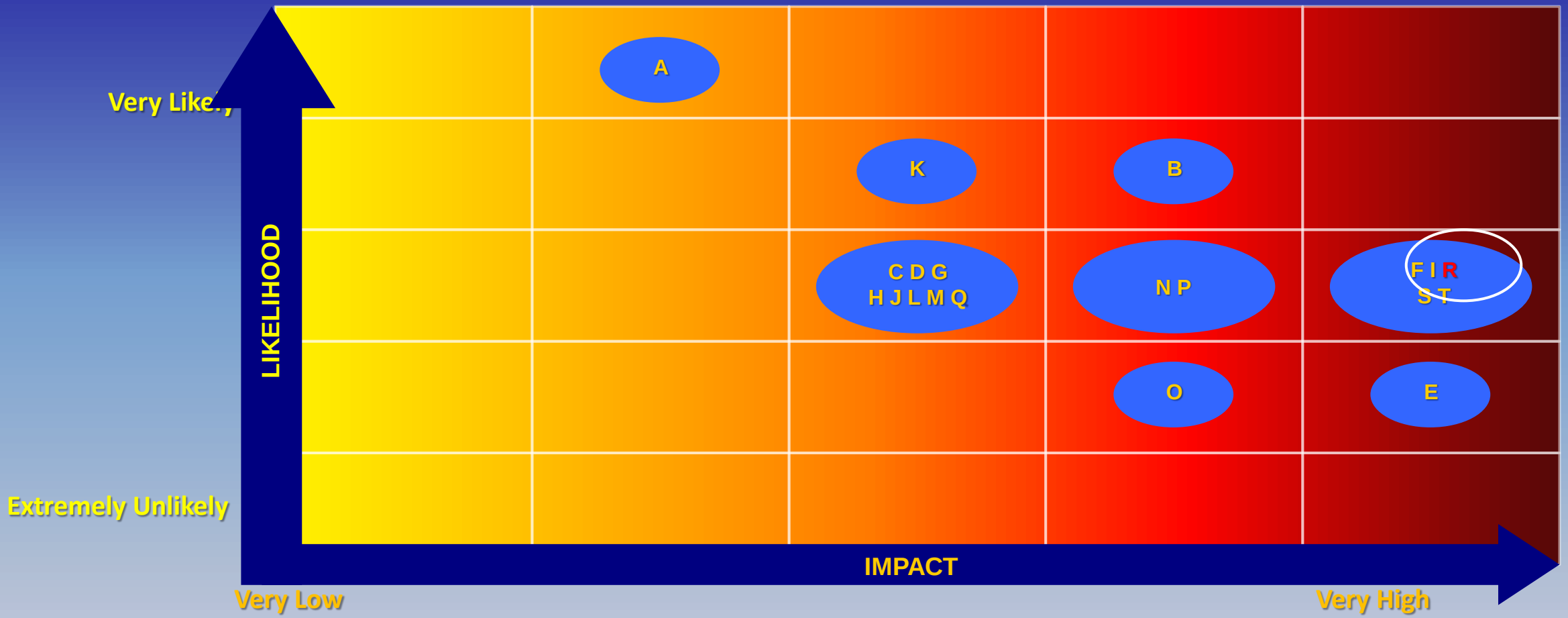
Expert:
Risk Perception

NRA 2017

National Risk Matrix 2017



A. Storm ***
B. Flooding ***
C. Snow ***
D. Low Temp. ***
E. Tsunami ***
F. Infectious Disease ***
G. Terrorist Incident ***
H. Animal Disease ***
I. Food Contamination ***
J. Loss of Critical Infrastructure ***
K. Rail Accident ***
l. Aviation Accident ***
M. Maritime Accident ***
N. Transport Hub ***
P. Hazmat **
O. Industrial Incident **
Q. Fire ***
R. Nuclear Incident (Abroad) ***
S. Disruption to Energy Supply ***
T: Network & Information Security/Cyber Incident **

Risk Assessment Confidence Levels: *** High Confidence ** Moderate Confidence * Low Confidence

Descriptors – Nuclear Incident Abroad

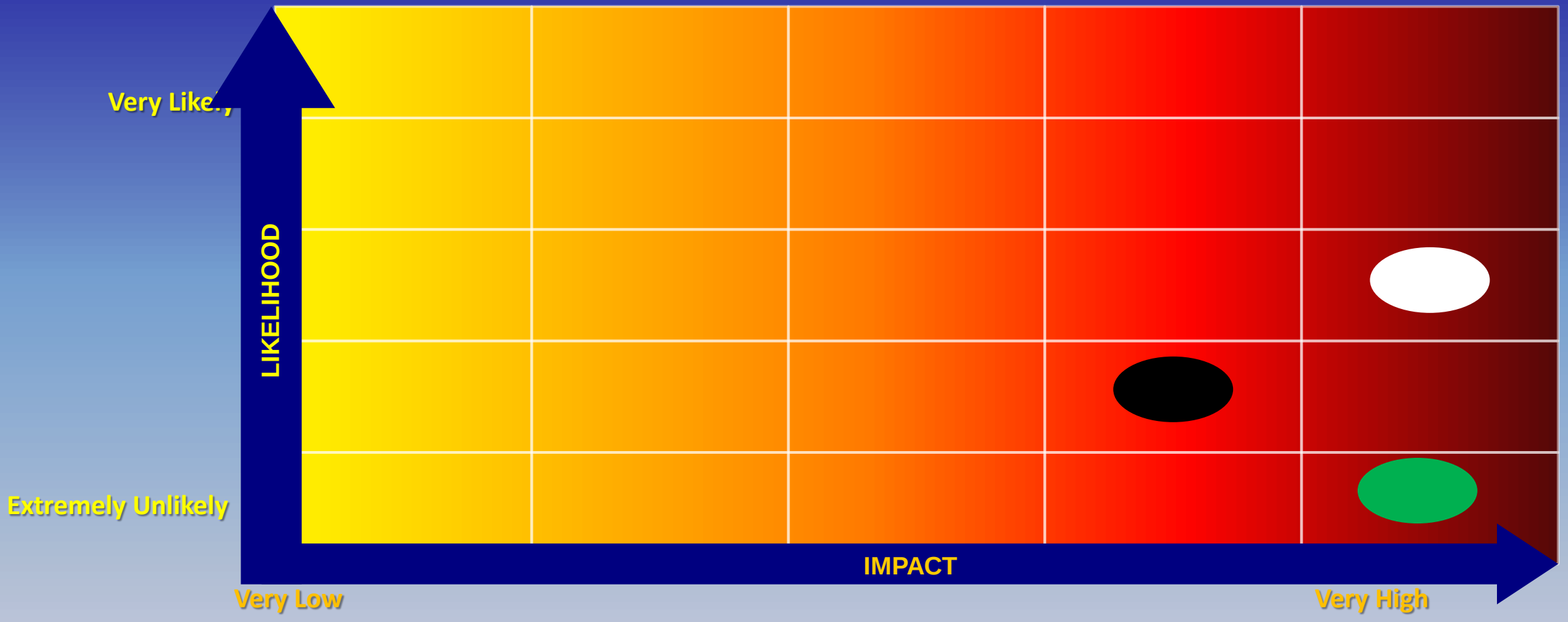
Likelihood Rating	Classification	Average Recurrence Interval
3	Unlikely	10 - 100 years between occurrences

Flooding	5 Very High Impact
People	Deaths greater than 1 in 20,000 people for population of interest OR Critical injuries/illness greater than 1 in 20,000
Environment	Very heavy contamination, widespread effects of extended duration
Economic	Greater than 8% of Annual Budget
Social	Community unable to function without significant support

Conf. Level	Criteria
High ***	Assessment based on expert knowledge of the issue and/or reliable, relevant, current data. Consistent agreement among assessors.

Public: Perception, Worry & Preparedness (2018)

Risk Rating: Nuclear Incident Abroad



Public - Mode

Public - Mean

Expert - NRA

Nuclear Incident Abroad: Likelihood & Impact

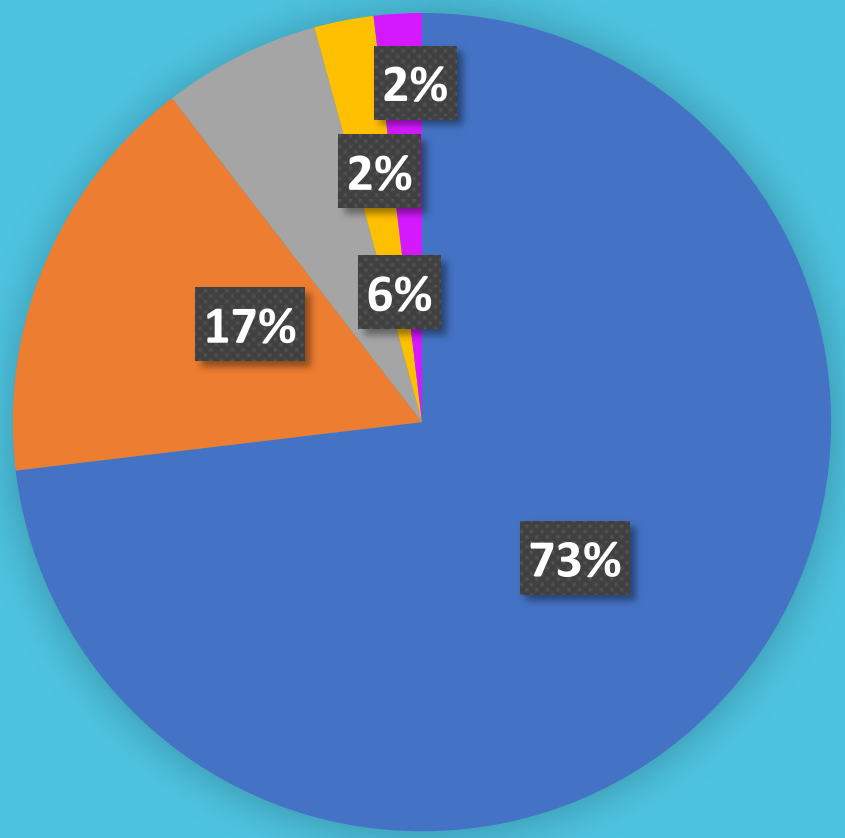
Nuclear (Abroad)	Code	Percent
Extremely Unlikely	1	47.4
Very Unlikely	2	18.8
Unlikely	3	23.3
Likely	4	6.3
Very Likely	5	4.2

n = 6007

Nuclear (Abroad)	Code	Percent
Very Low Impact	1	19.0
Low Impact	2	9.3
Moderate Impact	3	10.0
High Impact	4	18.0
Very High Impact	5	43.7

n = 5466

Nuclear Incident Abroad: Worry



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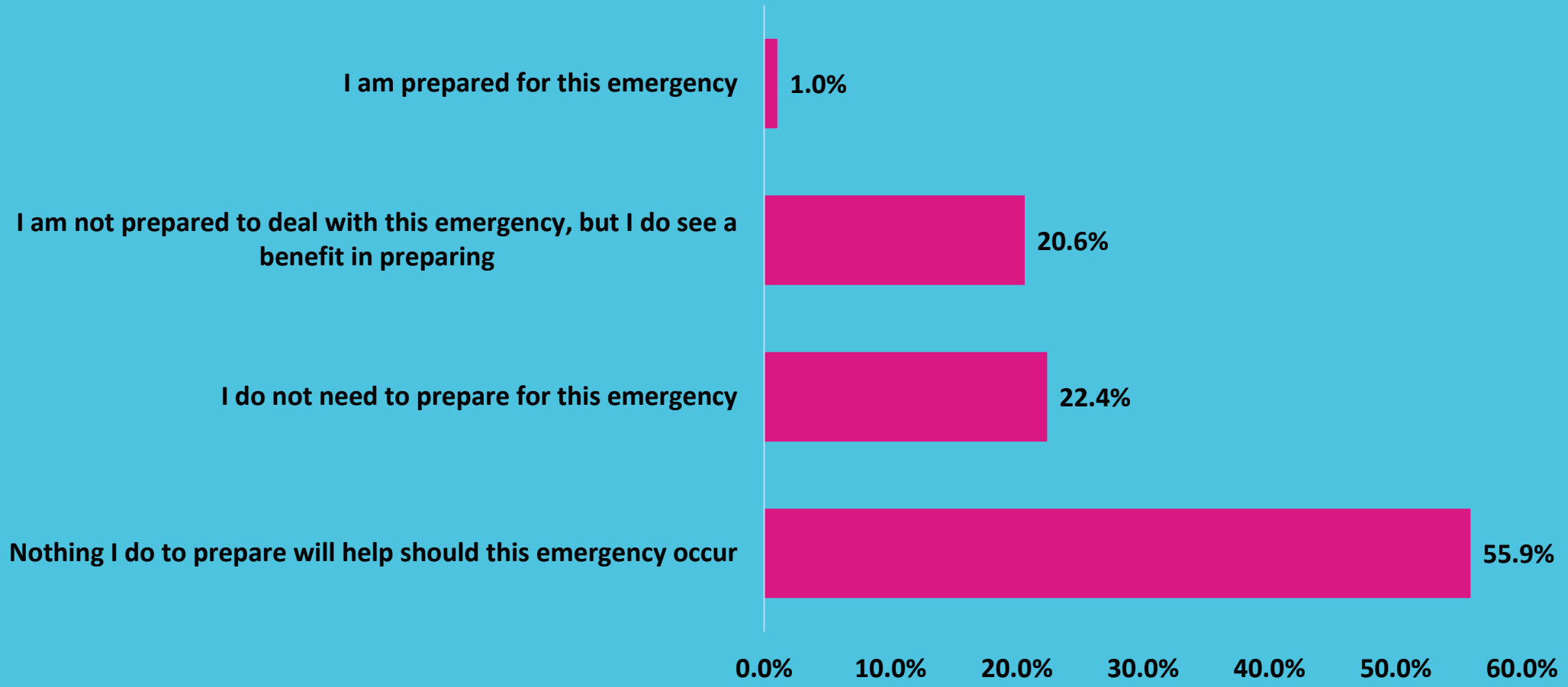
Preparedness



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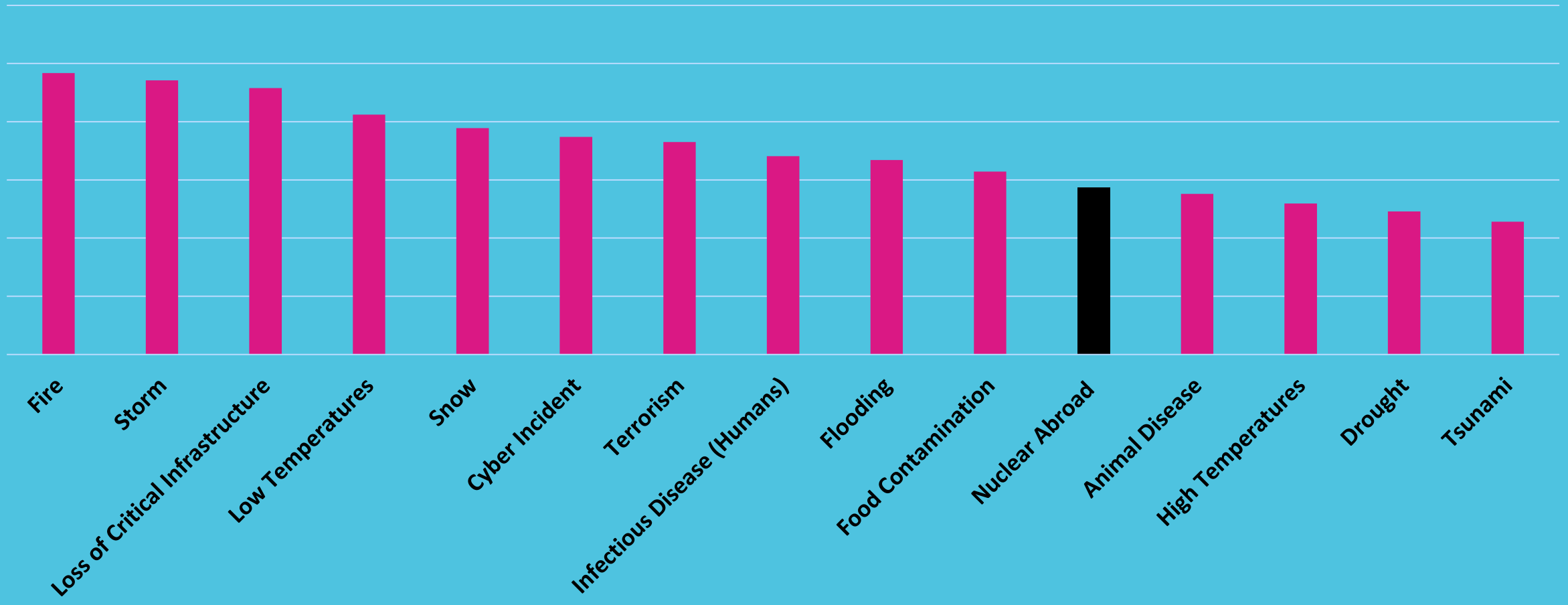
Relative Worry



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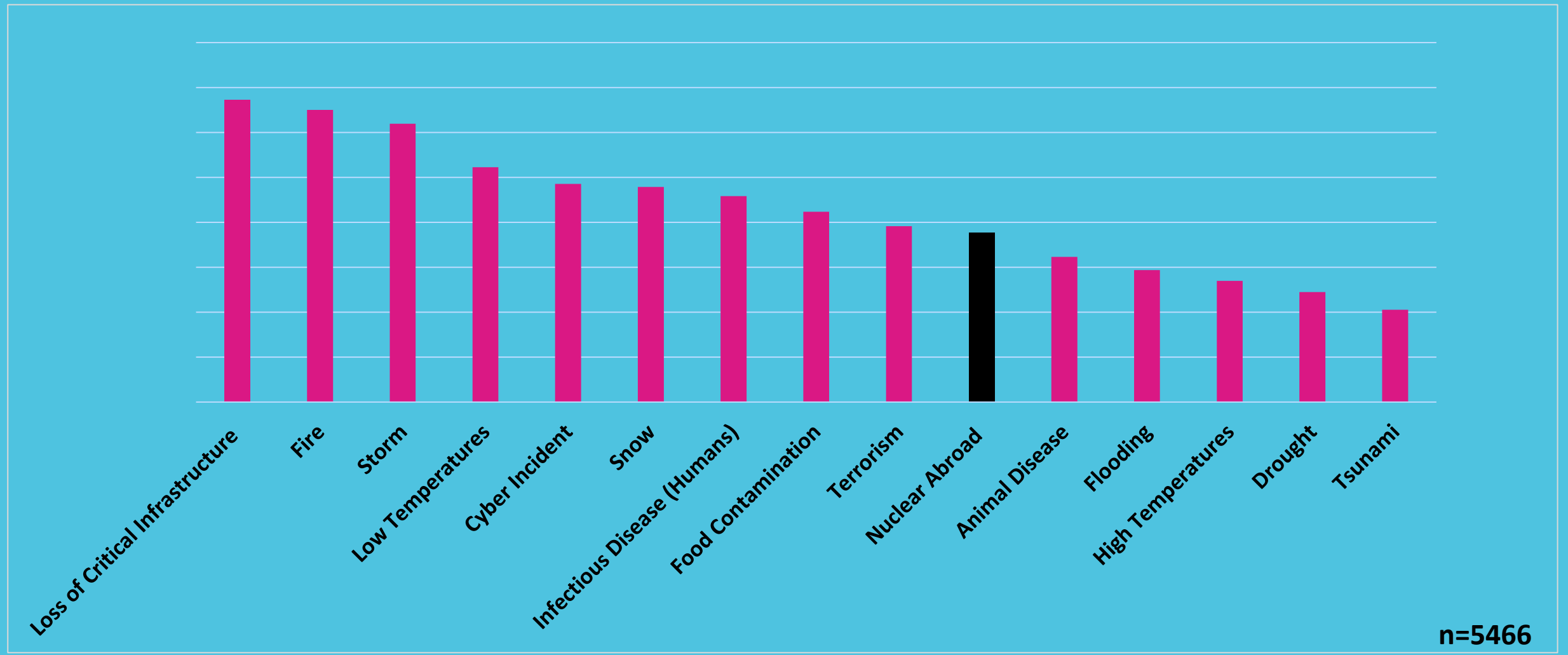
Relative Risk



Citation

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Ireland's National Plan for Nuclear Accidents.

Dr Ciara McMahon

Programme Manager (Air Quality & Emergency Preparedness)

Office of Radiation Protection & Environmental Monitoring

Environmental Protection Agency

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Irish Arrangements for a nuclear emergency

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Ciara McMahon

1986

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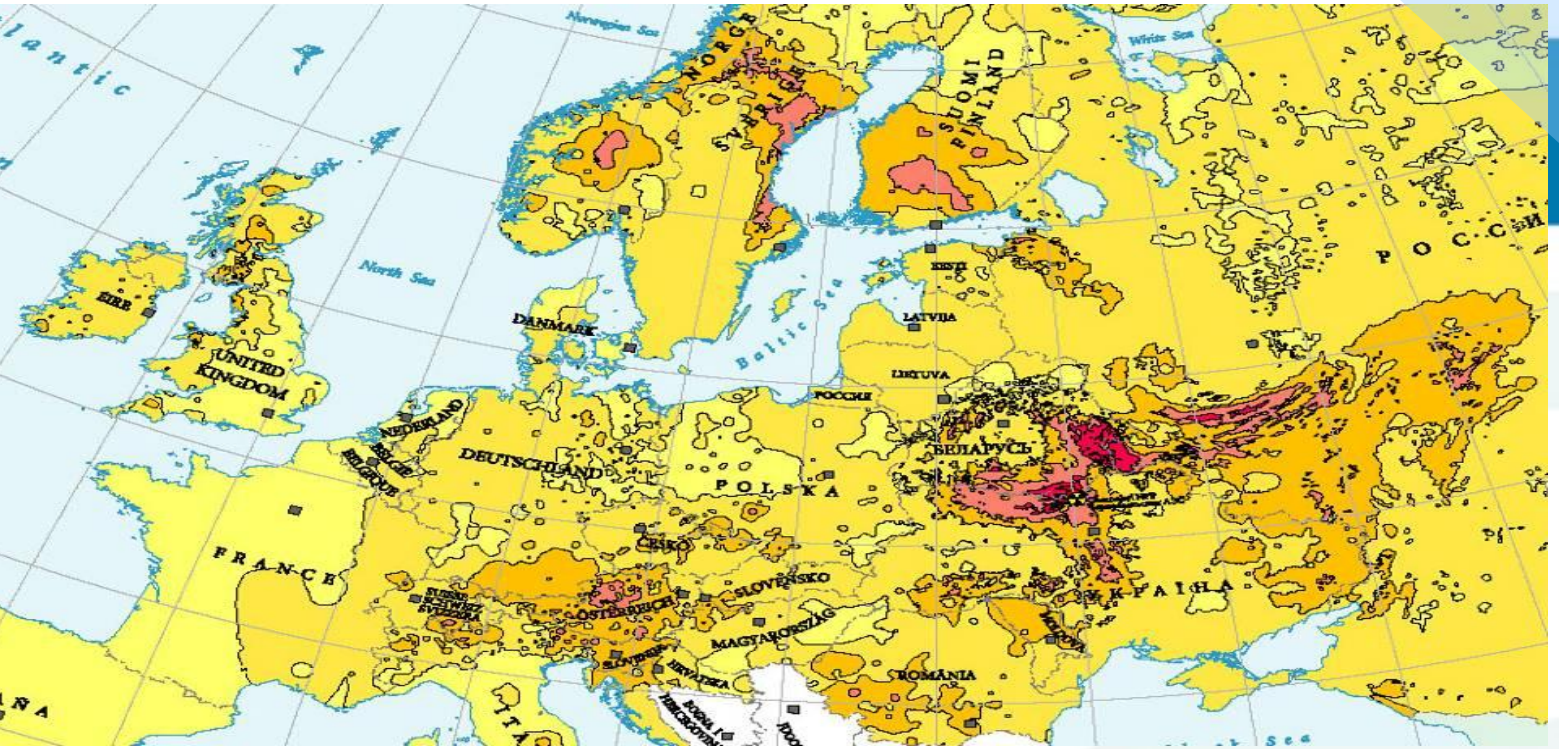
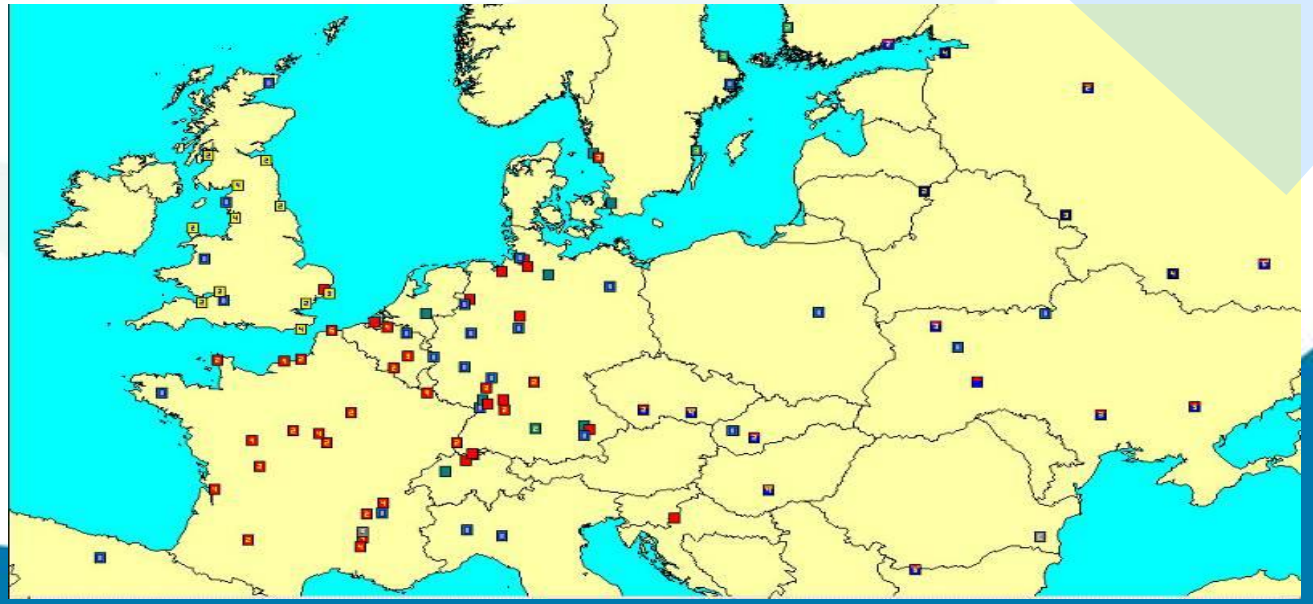


In 1986 concluded: Need a nuclear emergency plan!



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reeling
in the years

1996

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Joint Oireachtas Committee on Housing, Planning and Local Government – 3rd April 2019

*"…much of what I have learned, I learned from the **National Emergency Plan for Nuclear Accidents** and the experiences arising from it. Some of them were very bad experiences in the early days but they certainly **provided the basis for what we have now**."*

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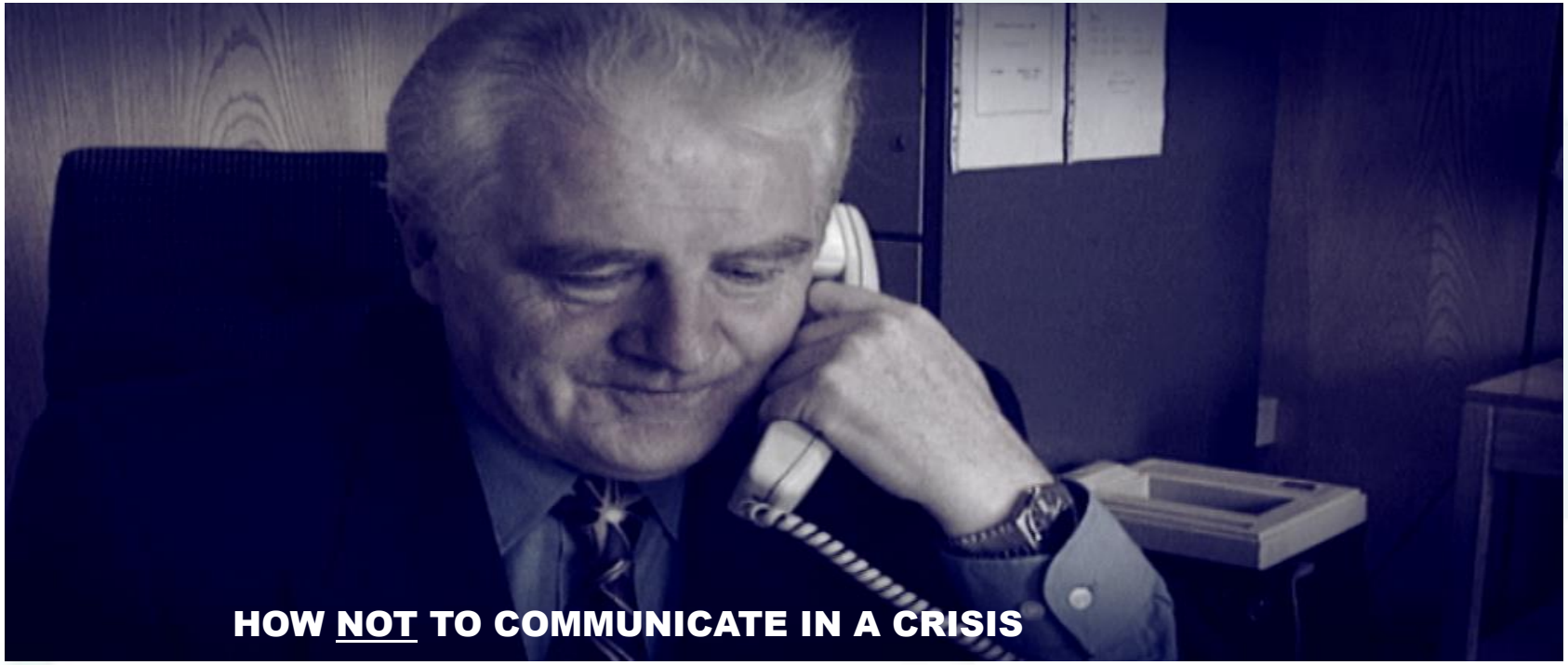
2001



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Systems Approach to Planning

Used at National, Regional and Local Level involving a continuous cycle of activity.

The principal elements of the approach are:

- **Hazard Analysis *(includes Risk Assessment - 5x5 Matrix)***
- **Mitigation *(includes Risk Management)***
- **Planning and Preparedness**
- **Co-ordinated Response and**
- **Recovery (incl. Review and Feedback)**

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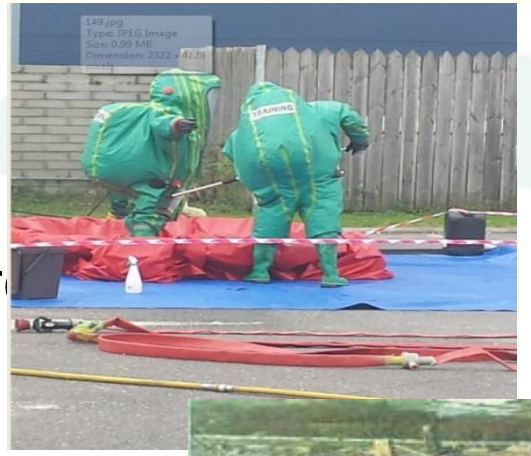
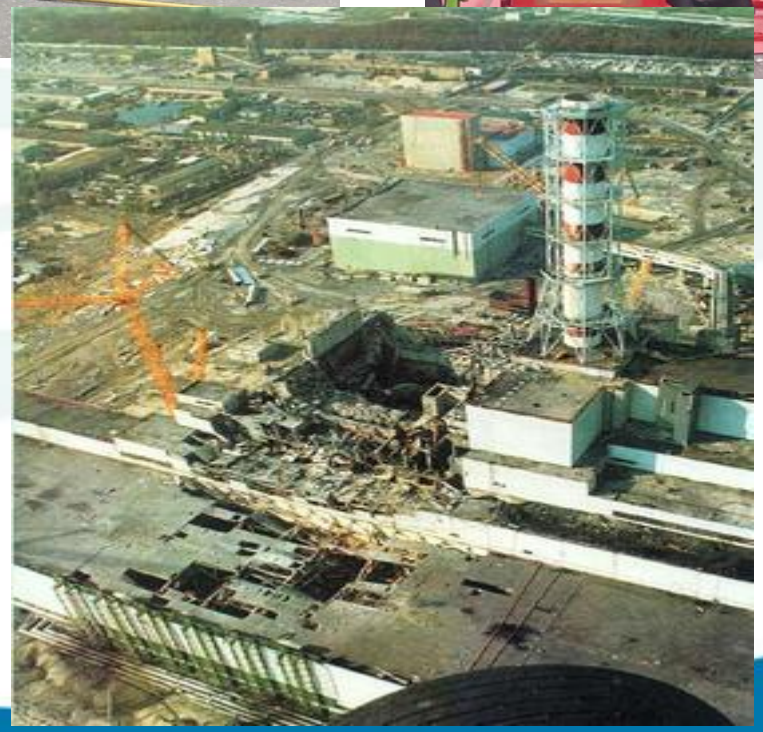
Step 1: Hazard identification and risk assessment

- Nuclear accident abroad
- Nuclear-powered vessel
- Incident involving licensed radiation sour Ireland
- Transport accident involving radioactive source in Ireland
- Lost/Found radioactive source
- Satellite re-entry
- …





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Key Hazard Assessments

Inside This Summary

The UK's Sellafield nuclear site, located on the Cumbrian coast, is at its closest point about 180 km from Ireland's coastline. Because of the site's location, its history, and the amount and type of radioactive materials there, the Government of Ireland and the Irish people have long been concerned about how an incident at the site might impact Ireland and the Irish Sea. Therefore, the Irish Government commissioned an assessm
experts to determine the
with the Sellafield Site an
located near the site.

The Sellafield nuclear site
that process and store us
other radioactive materia
stores low-level radioacti
assessment specifically a
equipment failures, natur
by human error or terroris
activities at Sellafield or t
scope of the commission
transportation of radioac
discharges from Sellafield
and are within limits set b
radioactive materials in t
monitored by the Radiolo

This document briefly sum
the assessment about the
Site and the Low-Level W
methods used to assess t
sites, and the risks to Irela
the analysis assesses risks
Waste Repository from th
materials and existing pro
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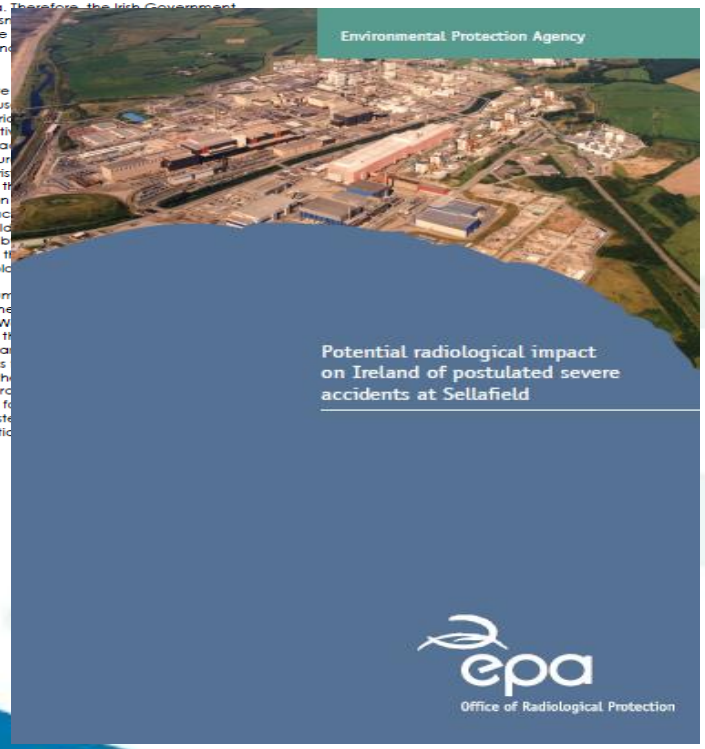
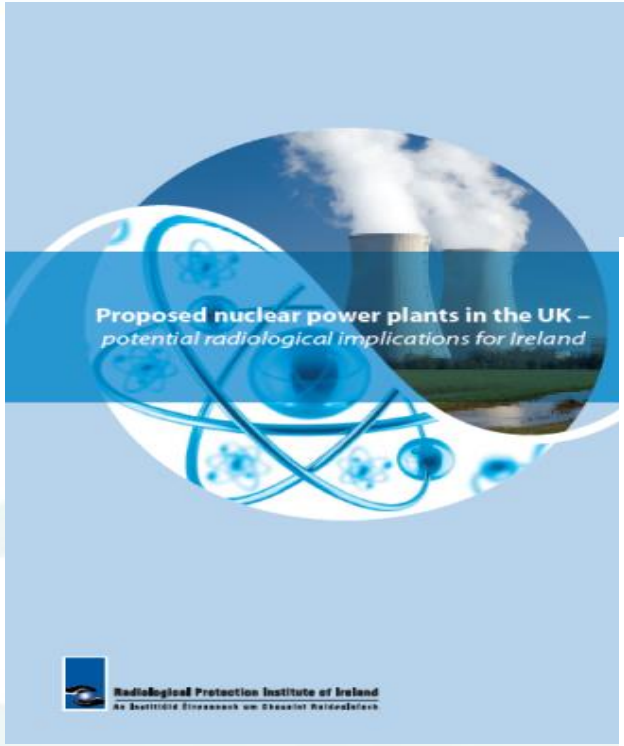
Sellafield and more waste
Repository. The informatio





1. Incidents involving radioactive sources under regulatory control

Ireland uses radioactive materials in the form of sealed and unsealed sources in support of industry, medical diagnosis and treatment and other societal infrastructure. To ensure the safety and security of all sources of radiation held throughout Ireland, the EPA operates a licensing system.

As of 1st January 2014 there were 1698 active licences which are divided into different bands including industrial, medical, educational/research and laboratories, distributor, dental, veterinary and custody only (see Figure 1). These bands are further subdivided into 'levels' which depend on the complexity of the process and the number and activity of sources and irradiating apparatus being held and/or used.

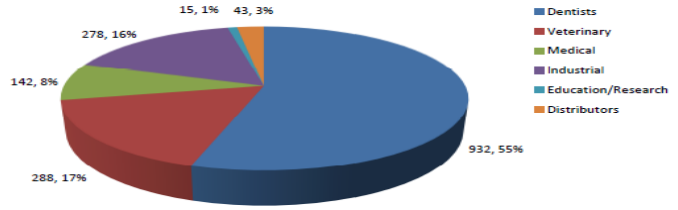


Figure 1. Licensees of Radiation Sources in Ireland by sector

In broad terms the following risks are associated with licensed sources:

Type of risk	Description of hazard
Loss or theft from storage location or during transit	Despite tight controls, loss/theft can occur. In responding to such events, it must be assumed that source may be with people who may not know its nature and hazard, who can handle it, break it and spread contamination. Hazard: The hazard depends on the type of radioactive source involved. For the highest hazard sources in Ireland (see list in Tables X to Y), unknowingly handling unshielded/unconfined sources could result in permanent injuries from external exposure or inadvertent ingestion and in localized contamination, requiring clean up.

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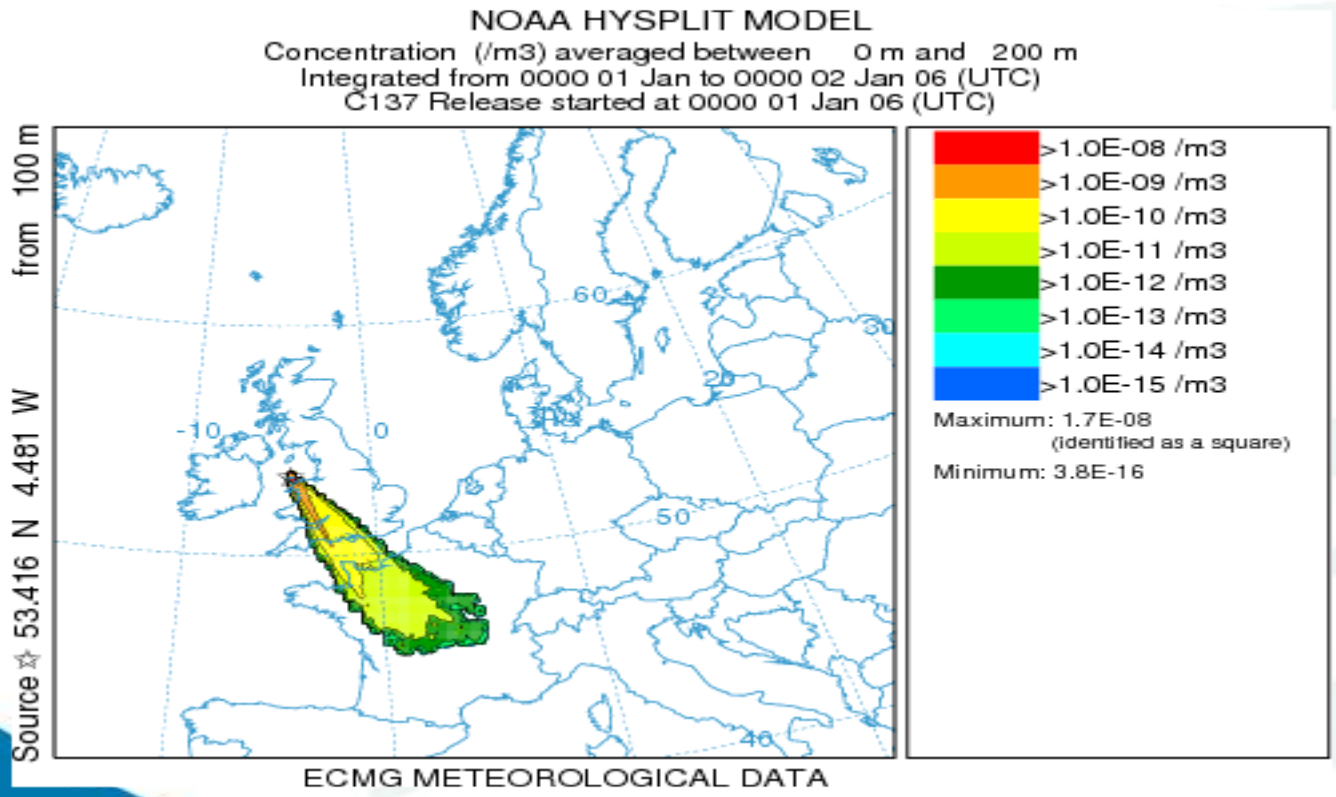
Environmental modelling



Used computer prediction models

- 21 years weather data
- Data on sea currents

Calculated resulting environmental levels in Ireland

Calculated radiation doses to people

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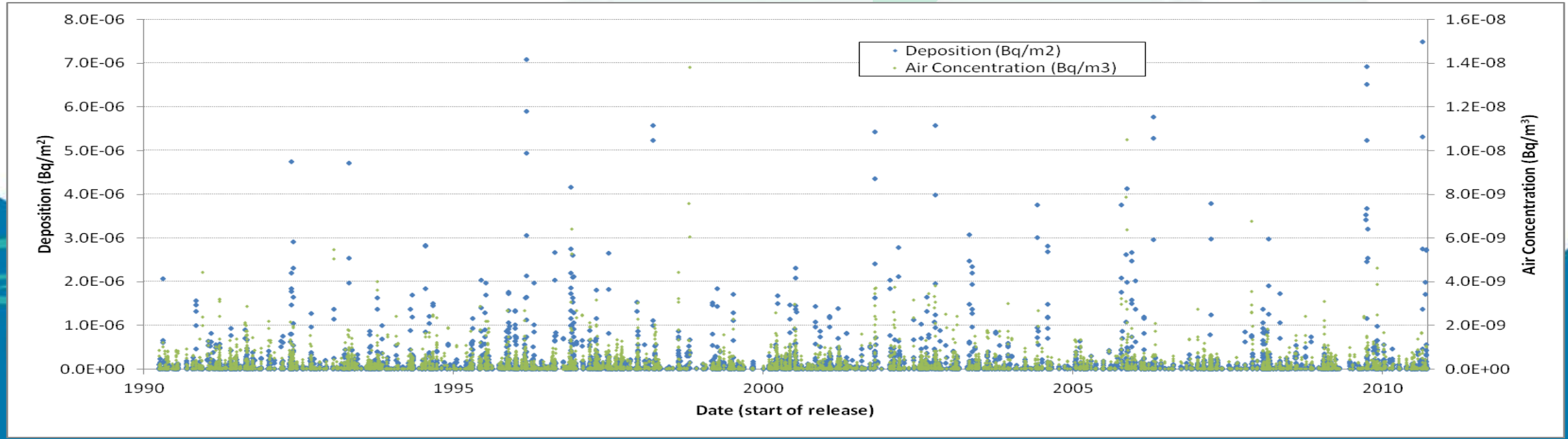
Identifying ‘worst case’ weather conditions

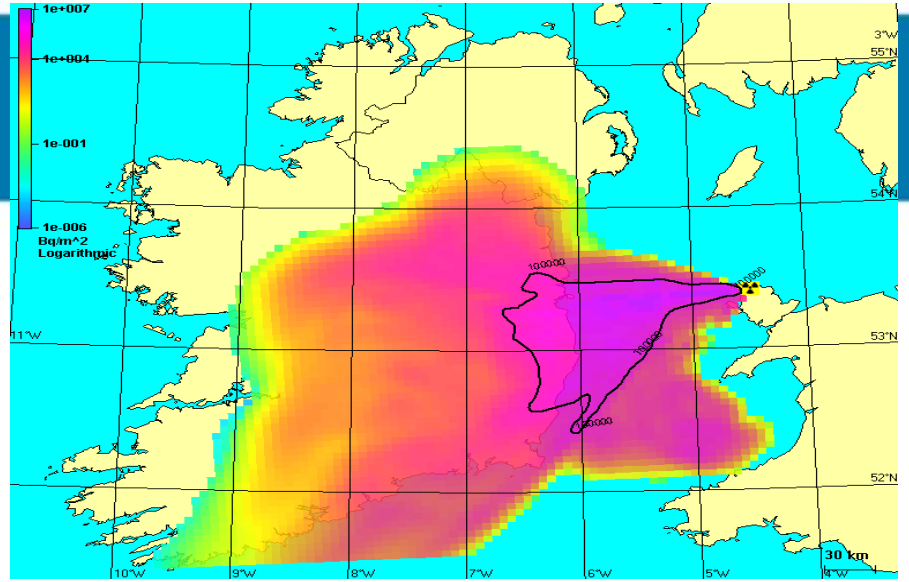
48 hour model run every 3 hours

Run model for each site

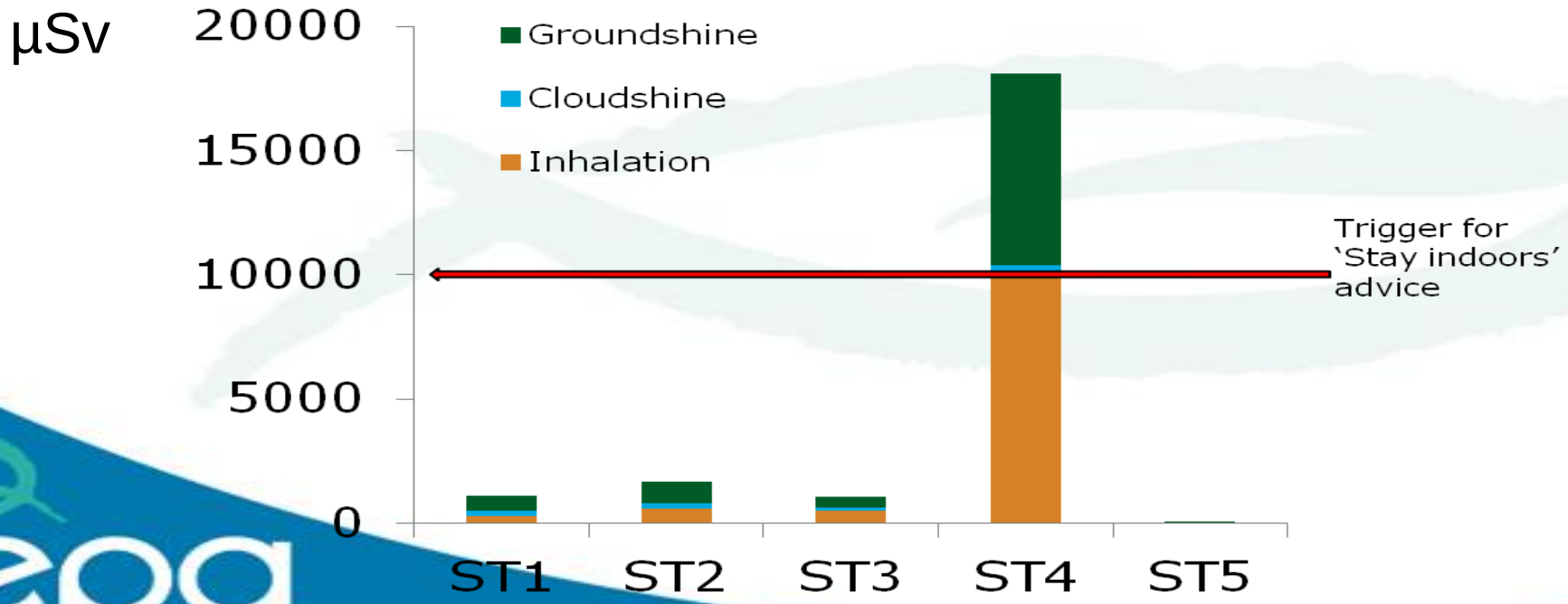
Identify maximum weather/site combination

Full assessment of this combination





Plume passage → 1 week → 1 year



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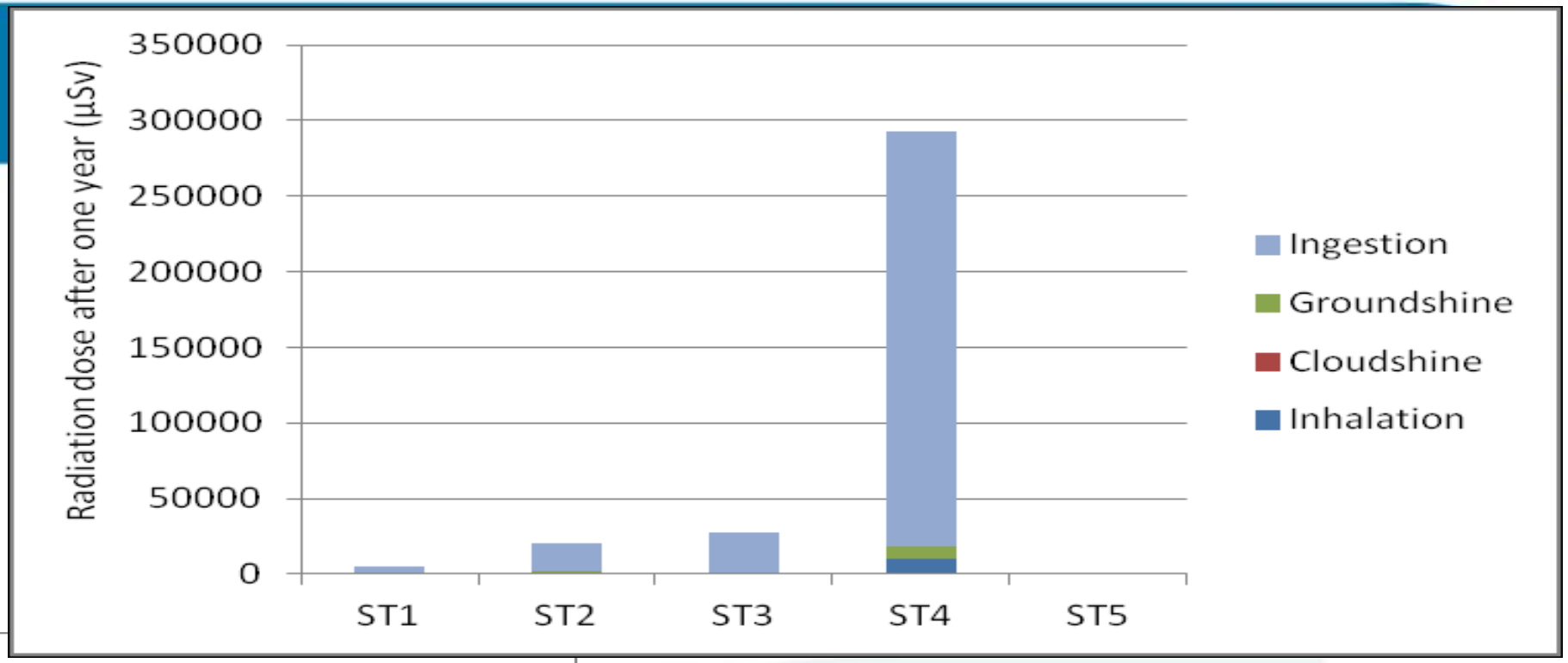
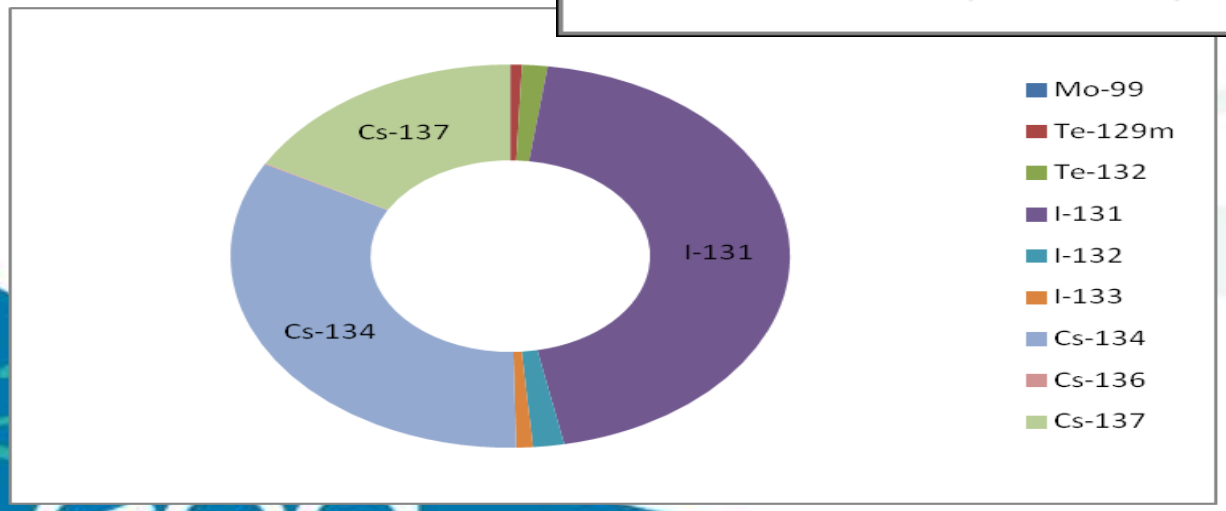
1 year





Ingestion dose by radionuclide

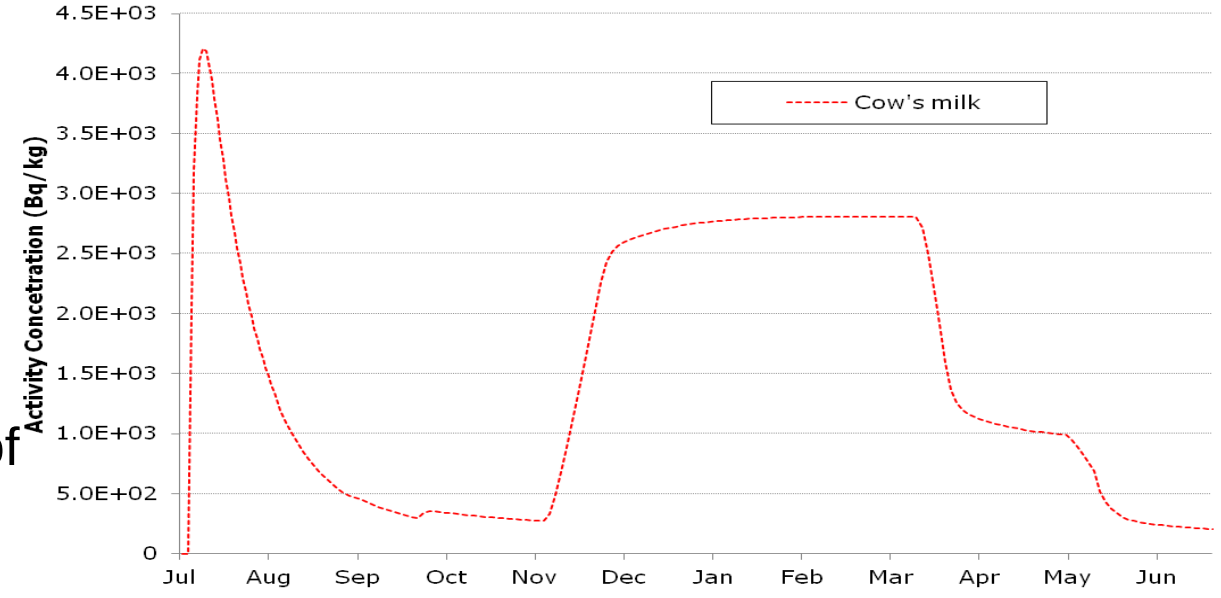
Contamination of food:

•Date of accident assumed was at height of summer – maximised impact on food

•Compared predicted levels in food with EU Maximum Permitted Levels

•Would generally need food controls/agricultural protective actions

•Length of time needed – would depend on severity of accident/weather/time of year



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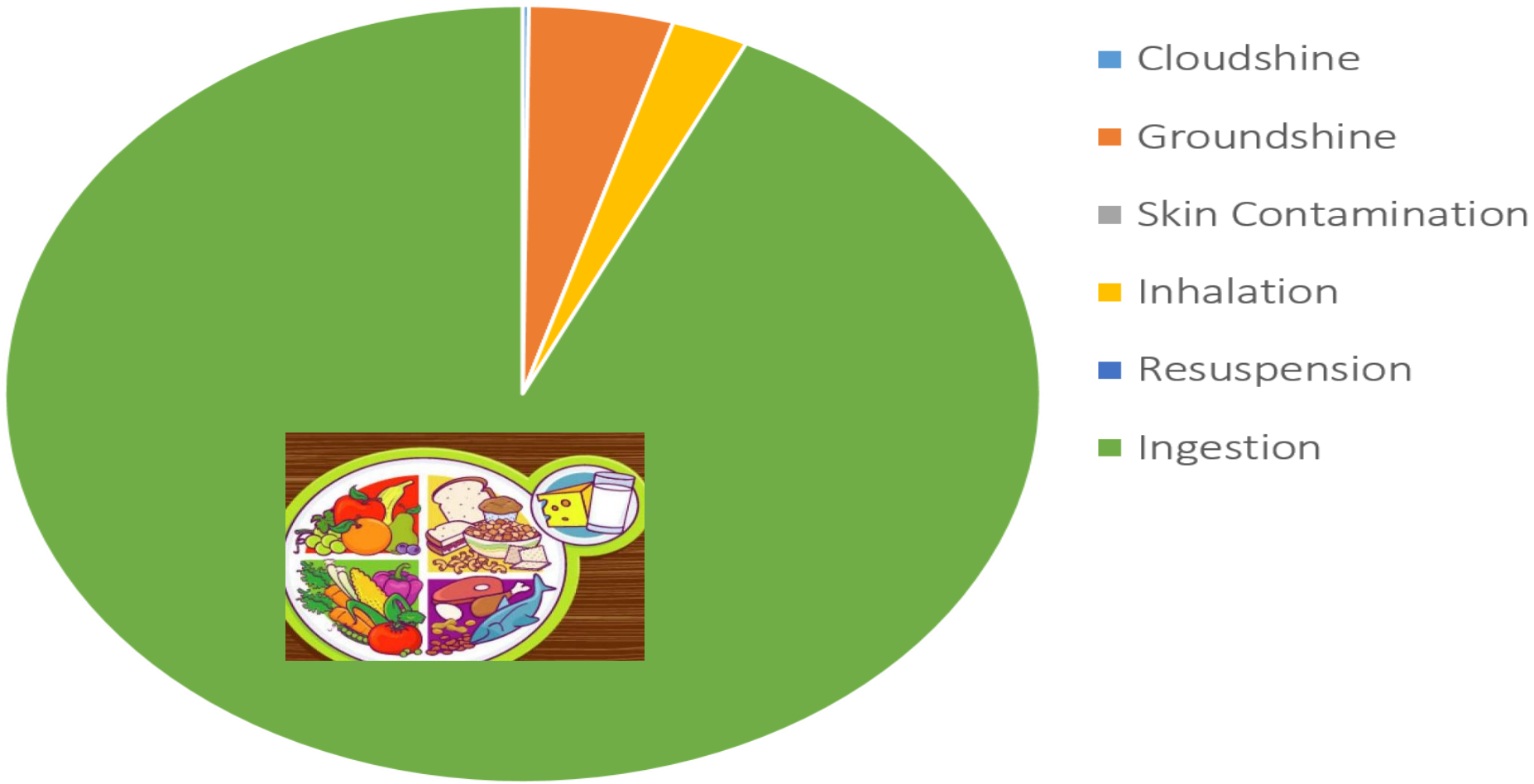
Cloudshine
Groundshine
Skin Contamination
Inhalation
Resuspension
Ingestion

epa
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Economic consequences

- Economic & Social Research Institute
- 4 scenarios
- Costs to economy
  - Agriculture
  - Tourism
  - Business (lost days)
  - Monitoring costs

➢ €4bn to €160bn

The Potential Economic Impact of a Nuclear Accident - An Irish Case Study

Prepared by the Economic and Social Research Institute
for the Department of the Environment, Community and Local Government

John Curtis, Edgar Morgenroth, Bryan Coyne

21 April 2016

This paper has been peer reviewed. The authors are solely responsible for the content and the views expressed. The Institute does not itself take institutional policy positions.

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Summary of hazard assessment

- Following a nuclear accident abroad the most significant route of potential exposure would be the consumption of contaminated food
- Most of the ingestion dose could be averted through the introduction of protective actions to reduce the transfer of radioactivity to food products and by restricting the sale of contaminated food
- Importance of agriculture and food to Ireland's economy

  - 15% of the world's infant formula is made in Ireland
  - Ireland is the 5th largest exporter of beef in the world

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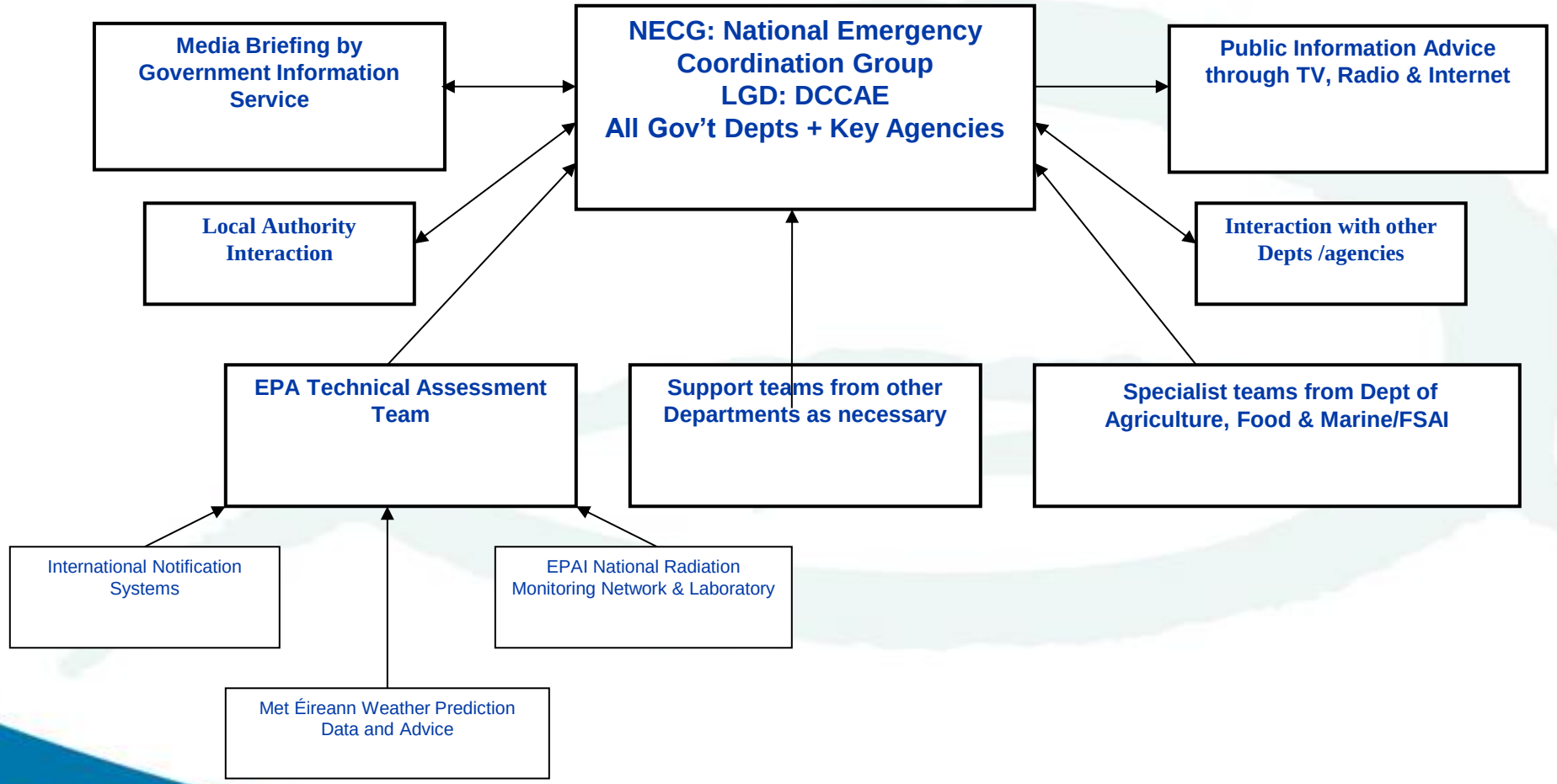
Response



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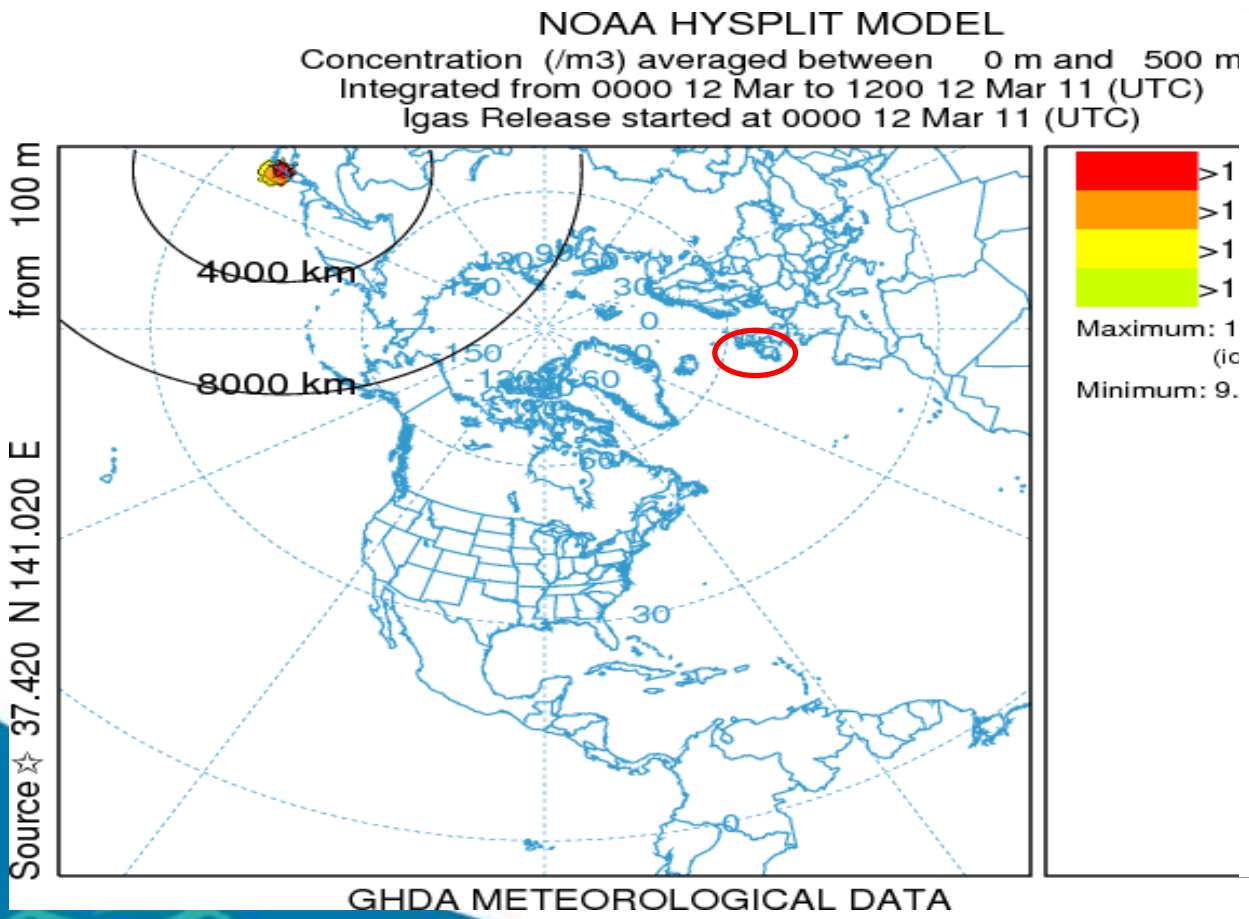
EPA Roles in an emergency



- Duty officer: assess notifications/alerts
- Briefings to Departments/Agencies
- Modelling/Measurement of radioactivity in environment and food/feed
- Food and pharmaceutical imports/exports testing
- Information to media/public
- Advice to Irish citizens abroad (through DFA)

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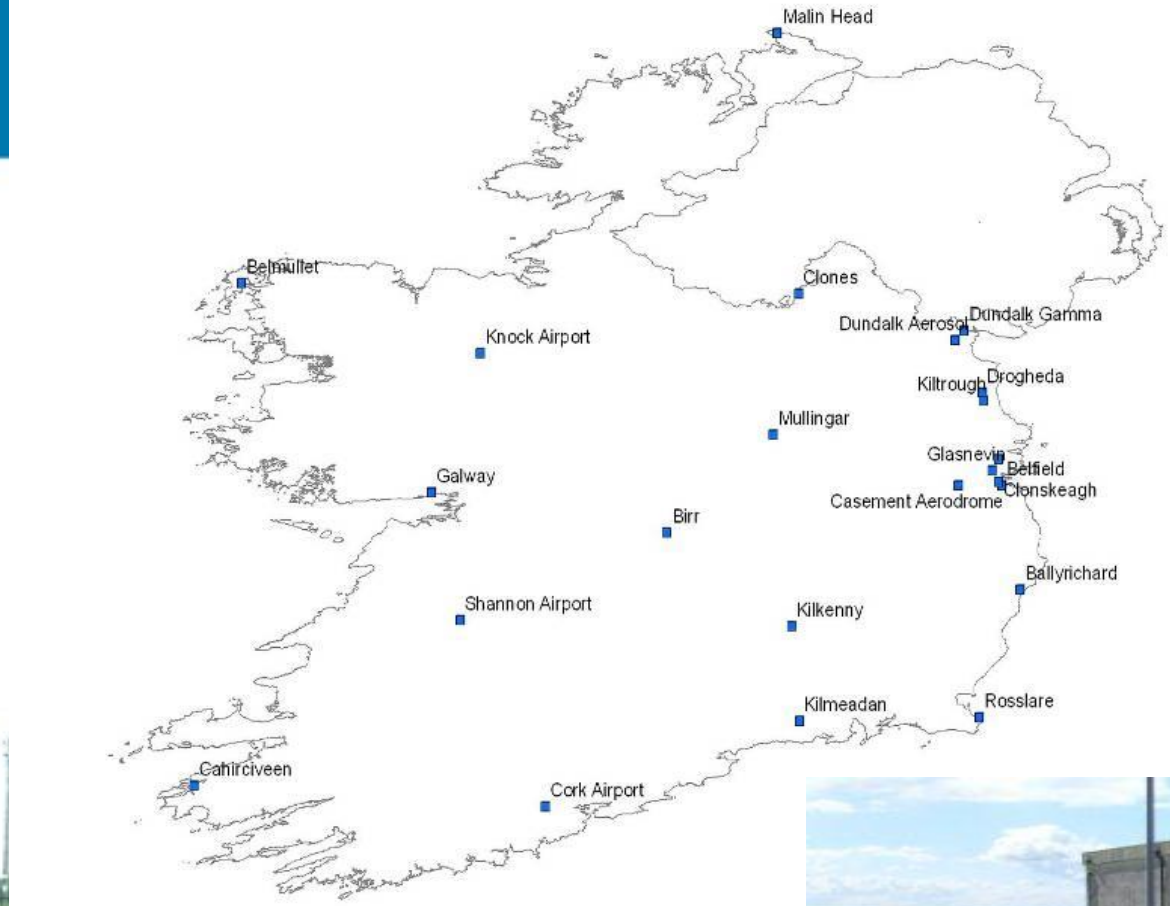
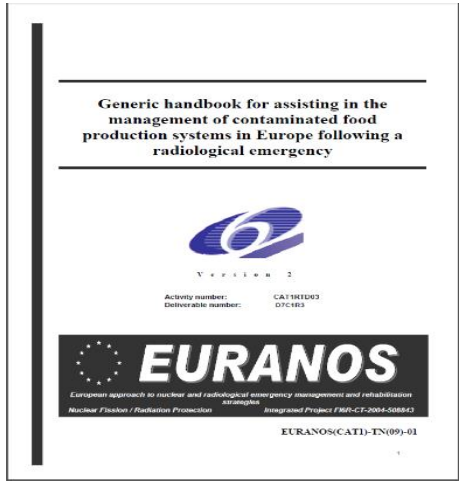

Malin Head
Belmullet
Clones
Dundalk Aerosol
Dundalk Gamma
Knock Airport
Kiltrough
Drogheda
Mullingar
Glasnevin
Belfield
Clonskeagh
Casement Aerodrome
Galway
Birr
Ballyrichard
Shannon Airport
Kilkenny
Kilmeadan
Rosslare
Cahirciveen
Cork Airport

EURANOS Food Handbook



Radiological	Dairy	Crops/Fodder
Meat (beef/lamb)	Pigs/Poultry	Food Safety
Sea Fisheries	Waste (environmental protection)	Laboratory

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Know that in an emergency, there would be MANY interested parties

In preparedness, harder to get people’s interest and time!

Our view of the world – radiation is a key focus!

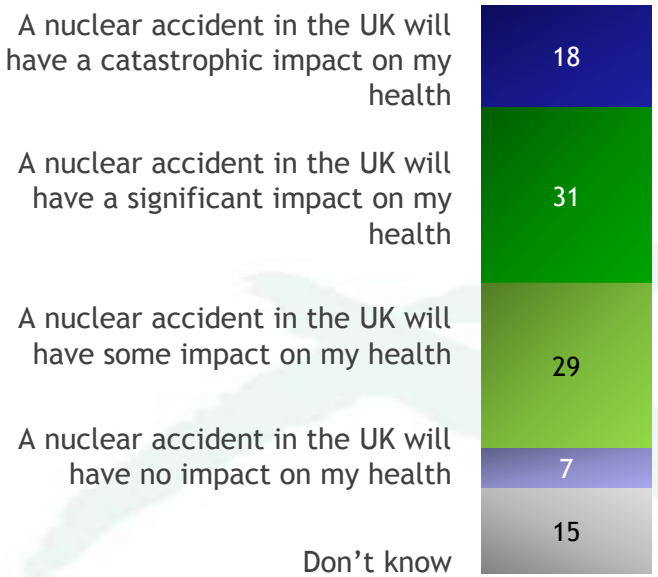
Our stakeholders have many hazards to think about – many more likely, more immediate

Still need to have public stakeholder views and assumptions for preparing for public communication

- We do not want to know the details of the various plans
- We want to know that there are plans
- And where to get information on them (when needed)

To gather public stakeholder views, used phone surveys, face-to-face interviews and focus groups

Q.10 – Q12 Please tell me which one of the statements on this card you agree with?



Public messaging: Need to meet people where they are, not where we are

Have to know 'where' they are (what assumptions they have on what will happen)

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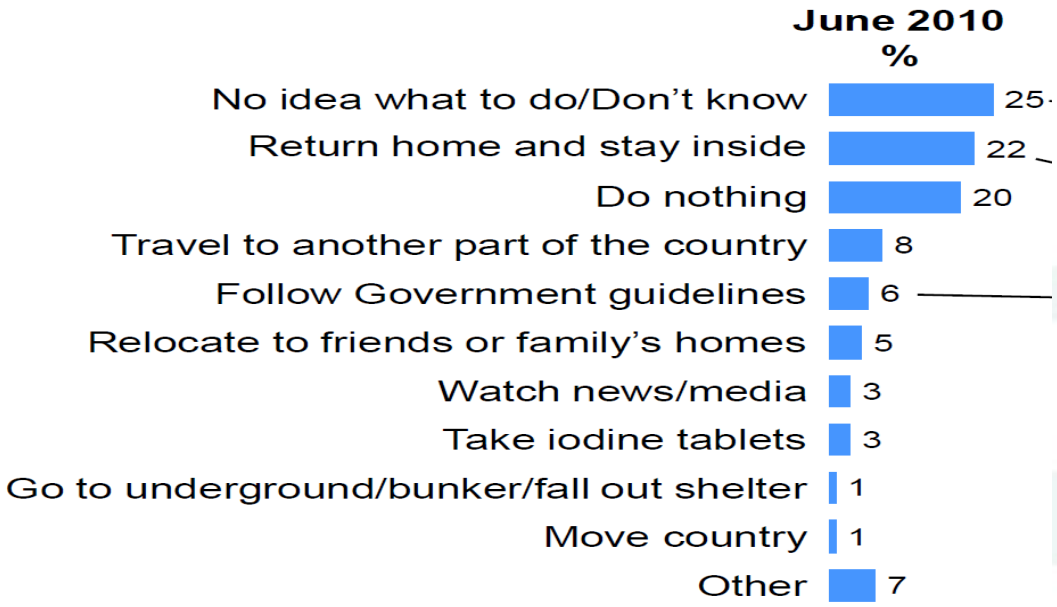

Base: All aged 15+ n=1000

Note: methodology changed from 2010 to 2013 (phone to face-to-face interviews)

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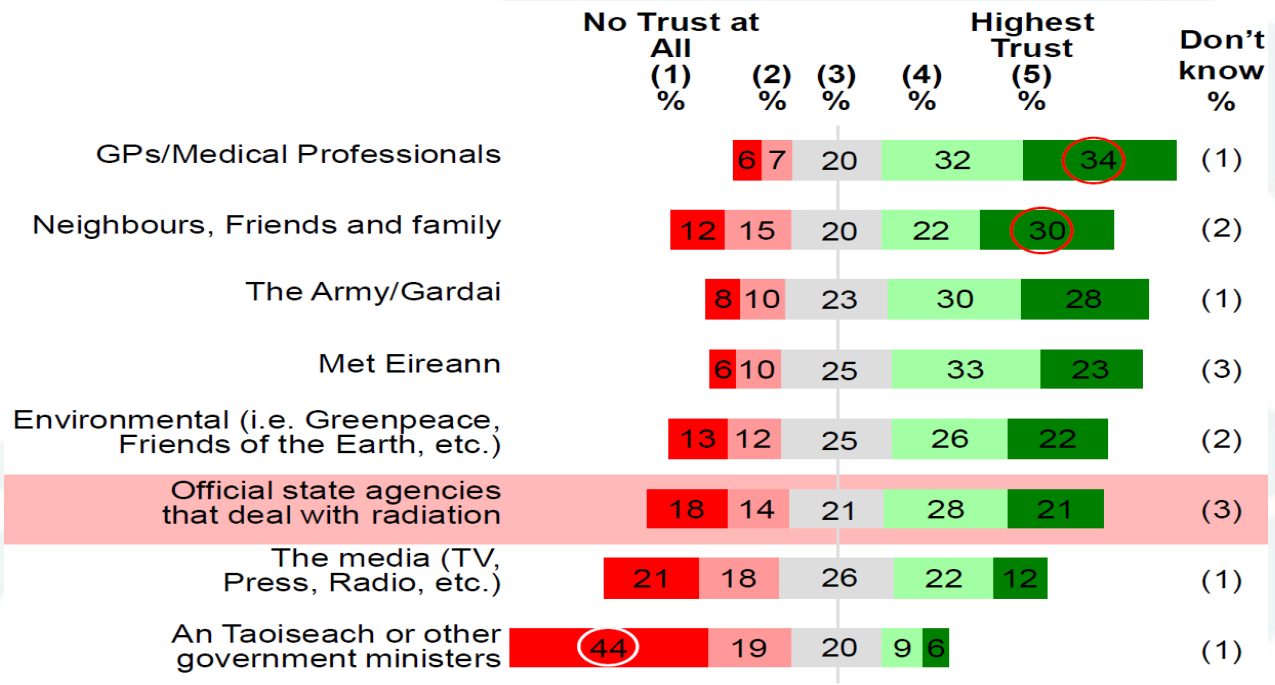
Who is trusted to give information in a nuclear emergency?



Updated plans to give prominent public information roles to Chief Medical Officer and Meteorological Service (as part of weather forecast bulletin)

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Stakeholder engagement: Panel

- Dept of Agriculture, Food & Marine
- Food Safety Authority
- EPA
- Dept of Environment
- Seafood Protection Agency
- Meat Industry body
- Dairy industry body
- National Consumer Agency
- Grain & Feed industry body
- Irish Farmers' Union
- Large retail organisations (supermarkets)

PREPARE

EUROPEAN JOINT PROGRAMME FOR THE INTEGRATION OF RADIATION PROTECTION RESEARCH
CONCERT

epa Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Regular meetings of stakeholder panel to present draft strategies and plans – get feedback on acceptability and practicality

Key Outcome from Panel Discussions

One of the most important issues in the event of a nuclear emergency is good **communications**

Communications with
- Farmers
- Processors
- Suppliers
- Retailers
- Consumers

Communications between industries is also very important e.g. between suppliers and processors

Therefore, all the stakeholders in the food industry must be involved in the communications plan

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Communication in an emergency

- Sub-Group of National Emergency Coordination Group
- Coordinate messaging across all Gov’t organisations

- Media (Radio, TV)
- Website: central and main organisations
- Social media (Twitter)
- Press conferences
- Direct to key business groups (agri-food)

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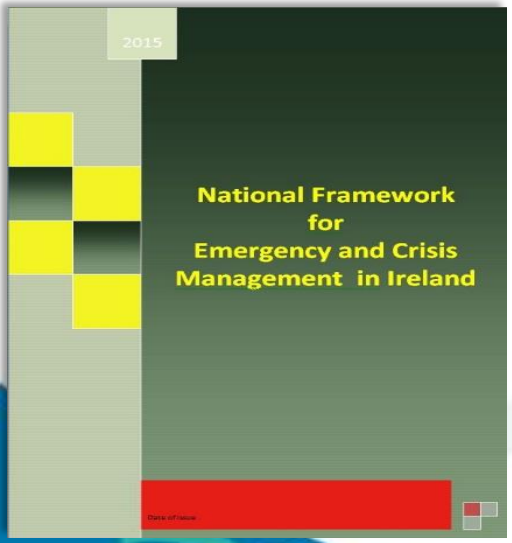
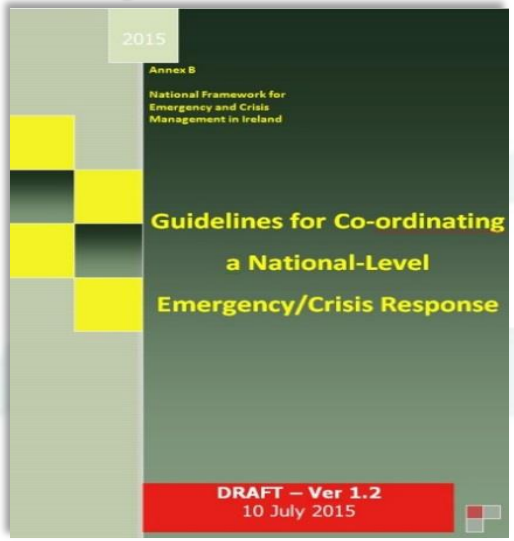
Further work

- Currently finalising major revision to the National Emergency Plan for Nuclear Accidents
- Maintaining Stakeholder Panel

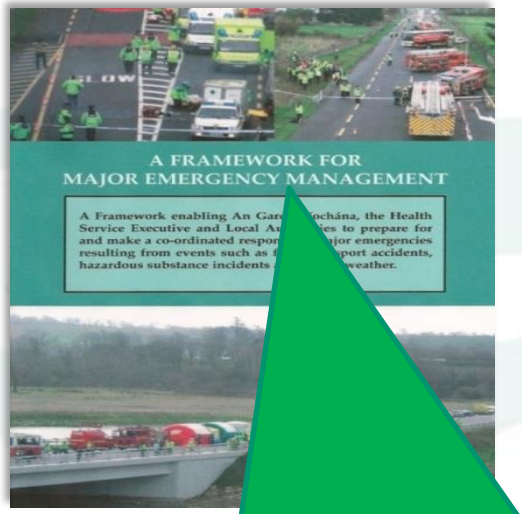
Nationally

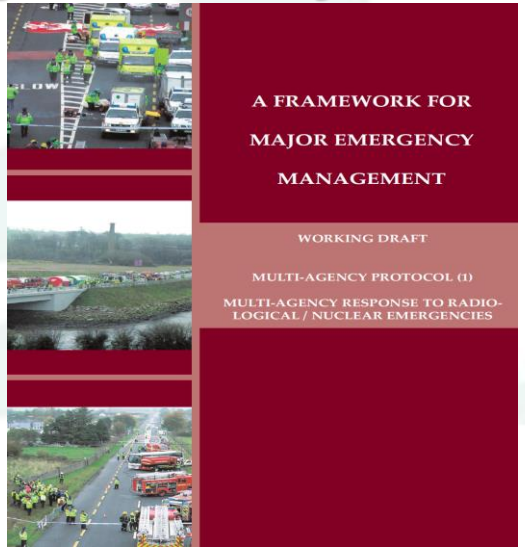




New National Framework 2017

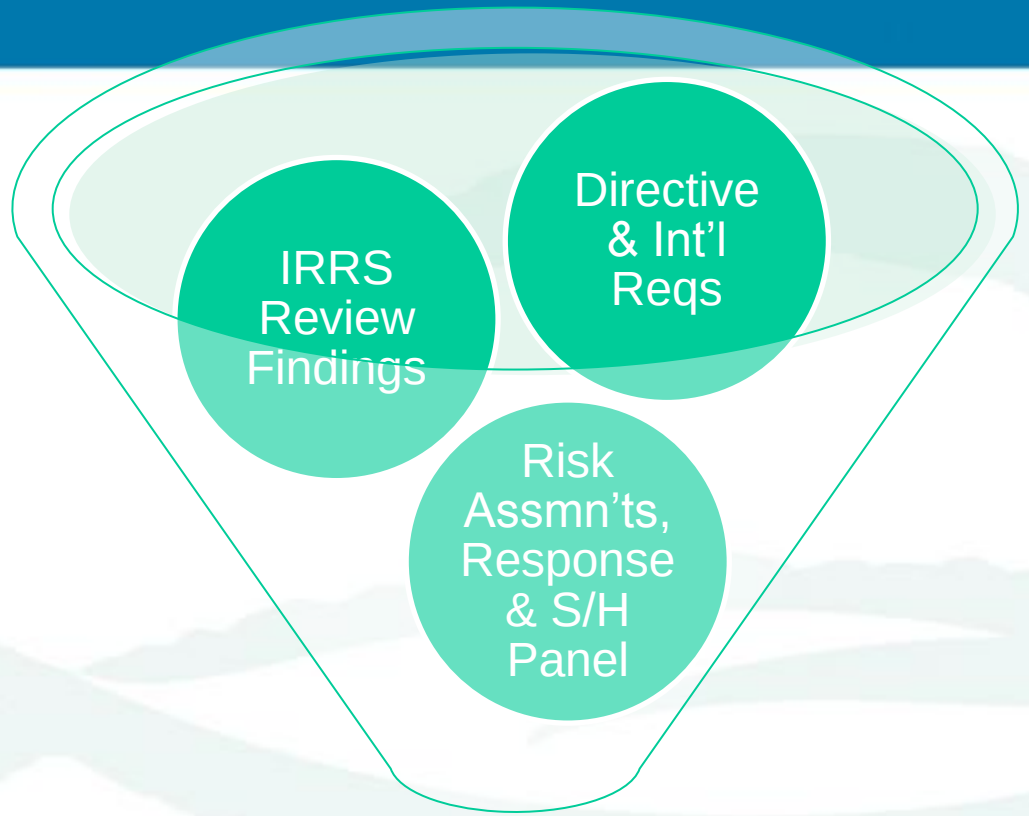
Nationally, Regionally & Locally





The MEM Framework is for the main PRAs, i.e. the Gardaí, HSE and Local Authorities

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil



Revised Plan for Nuclear Accidents

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An Ghníomhaireacht um Chaomhnú Comhshaoil

Final Words

Thank you to my colleagues:

Veronica Smith, Kevin Kelleher, Robert Ryan and Ciara Hilliard (EPA)

Sean Hogan and Keith Leonard (National Directorate for Fire and Emergency Management)

Thank you for your attention

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

www.epa.ie/radiation
www.emergencyplanning.ie

The Potential Economic Impact of a Nuclear Accident: An Irish Case Study

Professor Edgar Morgenroth

Full Professor of Economics

DCU Business School.

Join @ www.emii.ie

Disaster cost assessment: A case study of the potential economic impact of a nuclear accident affecting Ireland

Authors:

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Introduction

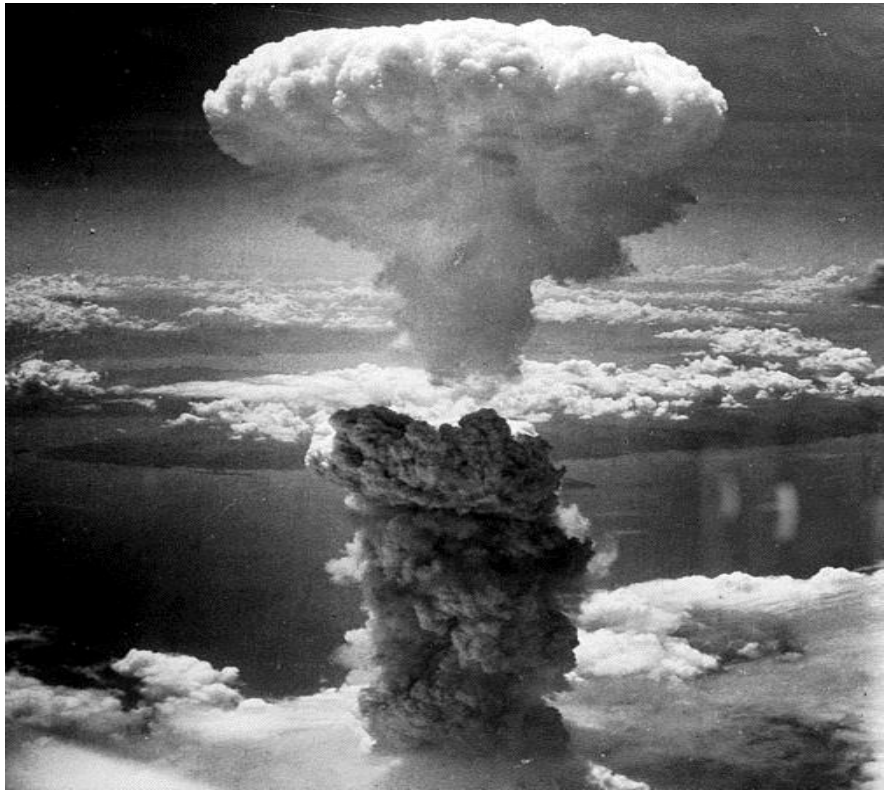
- The risks posed by Sellafield to Ireland were identified in Bley, D., Bell, J., Ryan, M., Stetkar, J., Wreathall, J. (2012) and the radiological implications of proposed nuclear power plants in the UK on Ireland (RPII, 2013)
- While these deal with the possible scale, nature and distribution of any fallout, they don't deal with the potential costs.
- Curtis, Coyne and Morgenroth (2016, 2018) assess the potential costs under different scenarios

Context

Conventions on Liability in the Field of Nuclear Energy

- Paris Convention
- Brussels Supplementary Convention
- Vienna Convention
- Protocols Relating to Vienna and Paris Conventions
- 1997 Amending Protocol
- Compensation Convention

Contamination not decimation



High impact, low probability events

- 2011 Fukushima Daiichi plant
- 2010 Eyjafjallajökull ash cloud incident
- 2004 Indian Ocean earthquake & tsunami
- 1986 Chernobyl

Economic Impact methodologies

- Input-output
- Computable general equilibrium (CGE)
- Econometrics

Objectives

Develop a methodology and use it to assess the potential economic impact.

- Order of magnitude guide
- Easily applied
- Low data requirement

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Method

Three types of costs/losses

- Direct costs
  - Disaster management costs & monitoring
- Direct losses
  - Lost/damaged produce
- Reputational losses
  - lost markets due to perceived contamination

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Full recovery?

- Seismic events
  - Mass migration
  - Capital flows

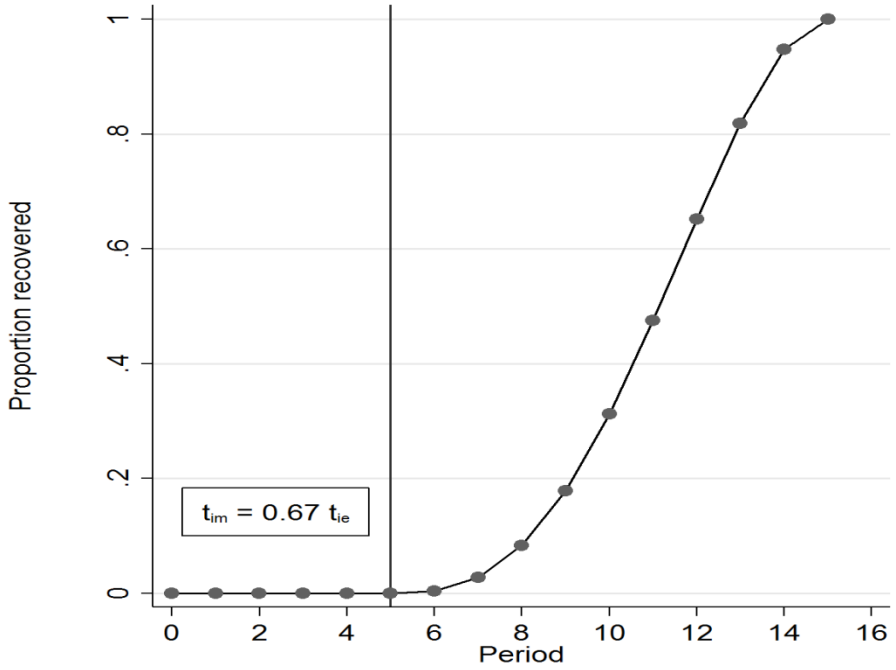
- Tractability

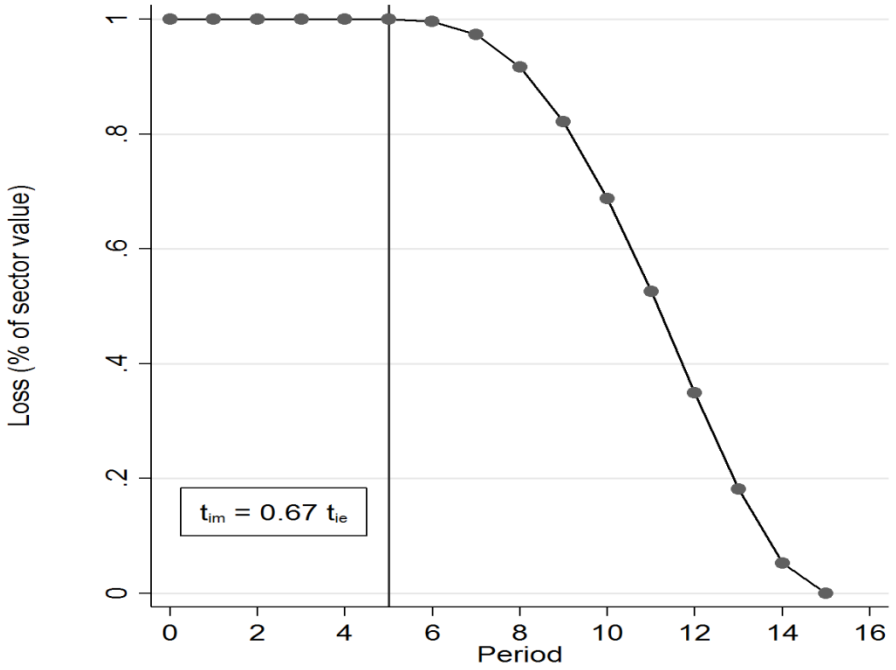
Reputational losses

Diffusion literature

- Initial shock
- S-shaped (sigmoidal) recovery function

Reputational losses





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Gompertz growth function

—Gompertz, B. (1825). Philosophical transactions of the Royal Society of London, 115:513–583.

—Prescott, R. B. (1922). Law of growth in forecasting demand. Journal of the American Statistical Association, 18(140):471–479.

—Winsor, C. P. (1932). The Gompertz curve as a growth curve. Proceedings of the National Academy of Sciences, 18(1):1–8.

—Yin, et al. (2003). A flexible sigmoid function of determinate growth. Annals of Botany, 91(3):361–371.

Proportional recovery

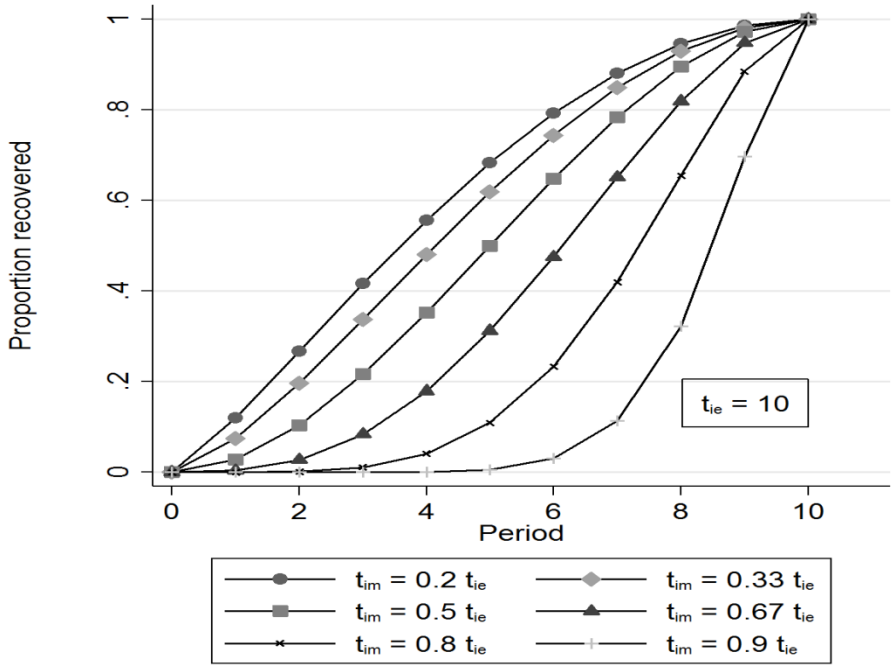
$$-\lambda_{it} = \left(1 + \frac{t_{ie} - t_i}{t_{ie} - t_{im}}\right)\left(\frac{t_i}{t_{ie}}\right)^{\frac{t_{ie}}{t_{ie} - t_{im}}}$$

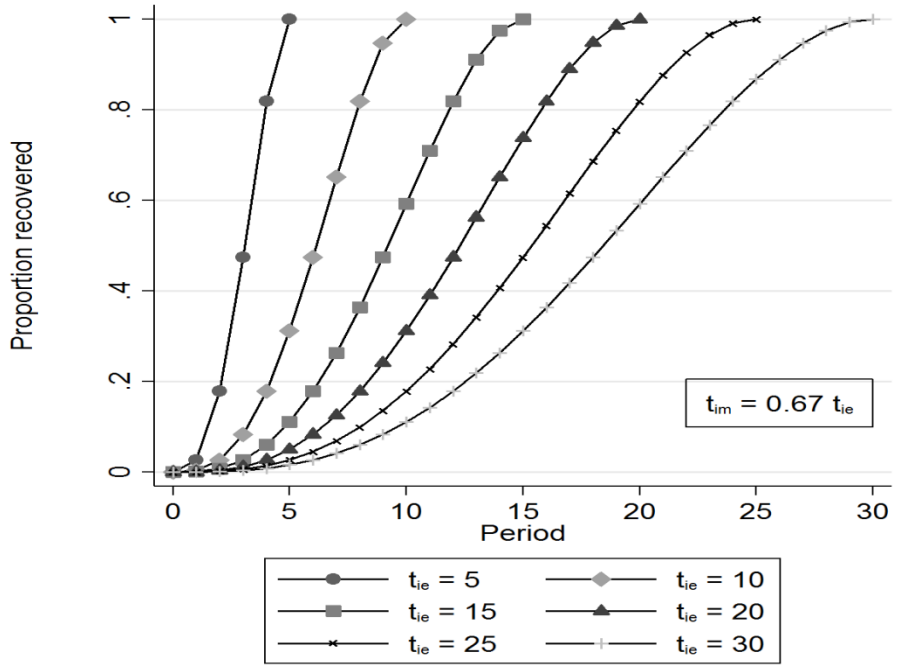
- industry i in time t
- t_{ie} full recovery time period
- t_{im} inflection point

t_{im} inflexion point

- Generally t_{im} > 0.5 t_{ie}
  - Gutiérrez et al., 2005; Dergiades and Dasilas, 2010; Kaldasch, 2011; Yamakawa et al., 2013
- Set $t_{im} = 0.67\ t_{ie}$

Proportional recovery: λ_{it}





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t_{ie}(when losses are fully recovered)

—Varies by scenario

Nuclear incident in north-western Europe:

1. No radiological impact on Ireland
2. Low-level environmental contamination
3. Moderate environmental contamination
4. High levels of radiological contamination

Impact assumptions

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Radiological Impact	None	Minimal	Substantial	Severe
Advice remain indoors	-	-	-	2 days
Loss of working days	-	-	-	3 days
Advice to keep livestock indoors	2days	4 days	8 weeks	-
Food/Environment Monitoring	2 weeks	9 months	10 years	30 years
Export Certification	-	7 years	10 years	60 years
Food import restrictions				
- IE to EU	2 weeks	9 months	1 year	3 years
- IE to Non-EU	2 weeks	9 months	5 years	15 years
Duration of reputational damage				
Tourism	6 months	1 year	6 years	15 years
Post EU import restriction	6 months	1 year	2 years	6 years
Domestic consumers	6 months	1 year	2 years	6 years
Post non-EU import restriction	6 months	1 year	10 years	15 years

Level of initial losses

$R_{i1} = \alpha_i V_i \qquad 0 \leq \alpha_i \leq 1$, t=1

— R_{i1}= level of initial loss

— V_i = total value of pre-incident activity

Assumptions for α_i

$$-\alpha_{agri} = 0.6$$

Source	Country	Crisis	Food	Peak to trough % change in demand
Philippidis and Hubbard (2005)	UK	BSE	Beef/Mutton/lamb Other meats	-72% in quantity -45% in quantity
Ishida et al. (2010)	Japan	BSE Avian Flu	Beef Chicken	-50% in quantity -25% in quantity
McCluskey et al. (2005)	Japan	BSE	Beef	-70% in value
Latouche et al. (1998)	France	Steroids	Veal	-40% in quantity
Niewczas, M. (2014)	Poland	Food Scares	Food	-30% in quantity
Carter and Smith (2007)	USA	GMO	Corn	-7% in price

Assumptions for α_i

$$-\alpha_{tourism} = 0.9$$

Source	Tourist Origin	Tourist Destination	Crisis	Impact
Enders and Sandler (1991)	USA	Europe	Terrorism	54% cancelled reservations
D'Amore and Anuza (1986)	USA	Overseas	Terrorism	79% avoid international travel
Stafford et al. (2009)		Ireland	Terrorism	32% would postpone trip
Mc Kercher and Hui (2004)	Hong Kong		Terrorism	39% changed travel plans
Ioannides & Apostolopoulos (1999)	Overseas	Cyprus	War	-18% arrivals
Mao et al. (2010)	Japan USA	Taiwan	SARS	-98% arrivals -90% arrivals
Huang et al. (2008)	Overseas	Taiwan	Earthquake	-15% arrivals
Mazzocchi & Montini (2001)		Italy	Earthquake	-50% arrivals

Decline in tourist numbers

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
UK	0.9	1.8	9.5	23.7
Rest of Europe	0.8	1.5	8.0	20.0
Rest of World	0.5	1.0	5.2	12.9
Total (million)	2.2	4.3	22.7	56.6

	Direct Loss Scenario 1 (€m)	Rep. Loss Scenario 1 (€m)	Direct Loss Scenario 2 (€m)	Rep. Loss Scenario 2 (€m)	Direct Loss Scenario 3 (€m)	Rep. Loss Scenario 3 (€m)	Direct Loss Scenario 4 (€m)	Rep. Loss Scenario 4 (€m)
Tourism								
UK	-	423	-	846	-	4,125	-	9,003
Rest of Europe	-	356	-	712	-	3,468	-	7,571
Rest of World	-	230	-	461	-	2,245	-	4,899
Agriculture	-	-	-	-	1,963	-	5,138	-
Monitoring & certification costs	-	-	6	-	1,460	-	4,311	-
Exports								
Livestock & animal feed	-	220	480	418	1,550	1,494	3,895	1,904
Meat, dairy, seafood	-	1,956	2,273	3,727	13,800	13,297	34,659	17,902
Cereals, fruit & vegetables	-	209	458	399	1,478	1,424	3,712	1,917
Other food, goods	-	747	1,631	1,422	5,265	5,074	13,224	6,830
Total	-	**4,141**	**6,842**	**7,991**	**25,516**	**31,127**	**64,939**	**50,026**

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Summary

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Direct Loss (€bn)	-	6.8	25.5	64.9
Reputational Loss (€bn)	4.1	8.0	31.1	50.0
Indirect Losses (IO) (€bn)	0.3	3.5	22.6	44.4
Total	**4.4**	**18.3**	**79.3**	**159.3**

- Substantial costs even without radiation
- Costs quickly escalate
- Many costs not considered
  - Health costs
  - Costs of contaminants disposal

References

Curtis, J., Coyne, B. and E. Morgenroth (2016) The Potential Economic Impact of a Nuclear Accident - An Irish Case Study. Dublin: Department of Communications, Climate Action and Environment

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Q&A

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