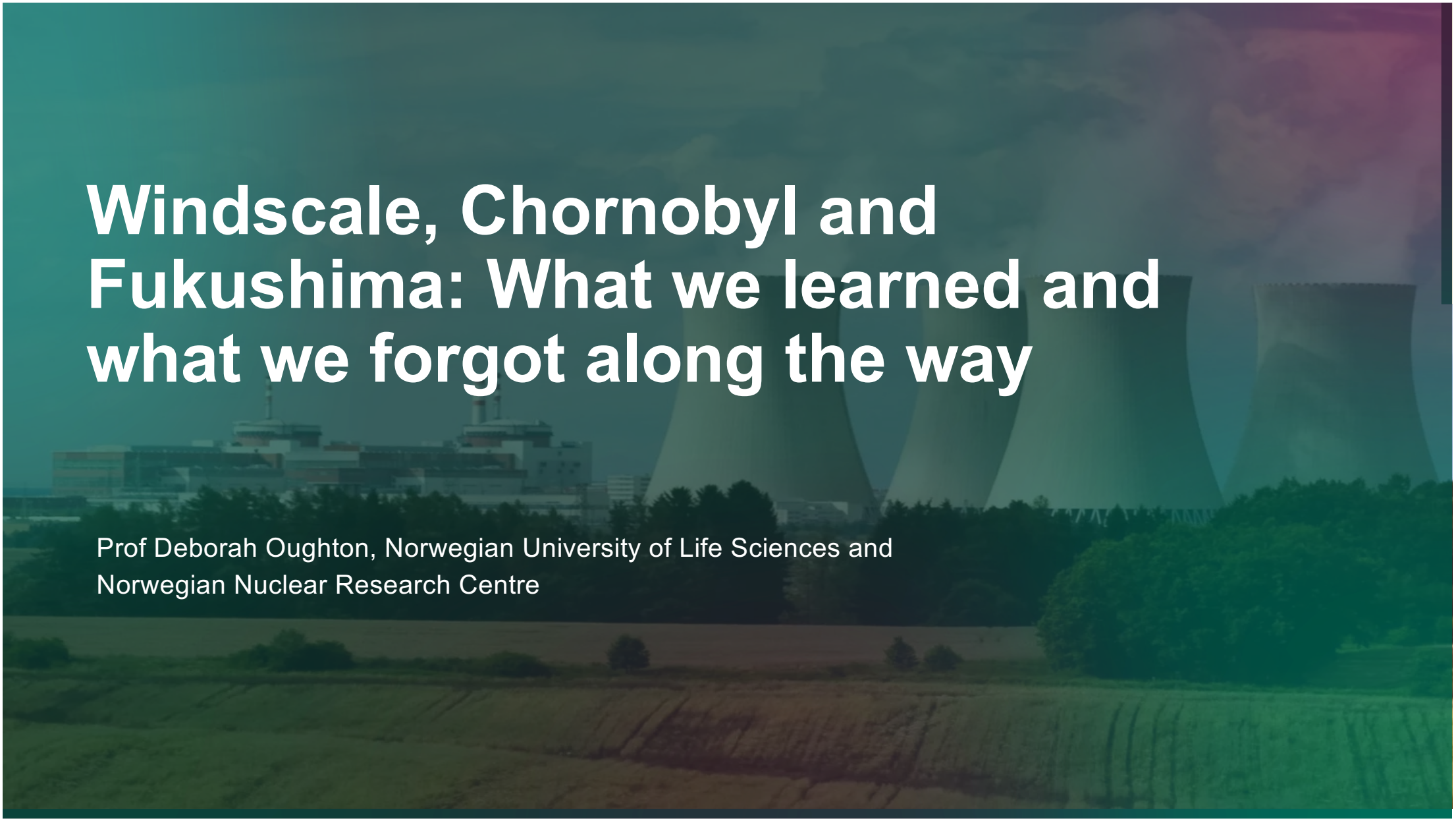


Windscale, Chornobyl and Fukushima: What we learned and what we forgot along the way

Prof Deborah Oughton, Norwegian University of Life Sciences and
Norwegian Nuclear Research Centre

Windscale Fire, October, 1957

Two plutonium production reactors (“piles”), Graphite moderated, air –cooled.

Burst fuel element, and subsequent fire burning in the reactor for a couple of days.

Eventually extinguished by pouring in water

Estimated releases:

- 1.8 PBq I-131
- 0.18 PBq Cs-137
- 26 PBq Xe-133

Sellafield (Windscale), 1960-1980s

Location: Cumbria, UK

Civil and military based reprocessing of fuel

Military Pu production started 1950

Calder Hall Nuclear Power Plant opened 1956

High discharges of radioactive waste to Irish Sea in 1970's and 1980's

High leukaemia rates in children observed in late 1970's

Studies of Radioactivity in the Environment

Monitoring of radionuclides in the environment by MAFF and NRPB

Lare amount of information on transport of radionuclides in human food chains

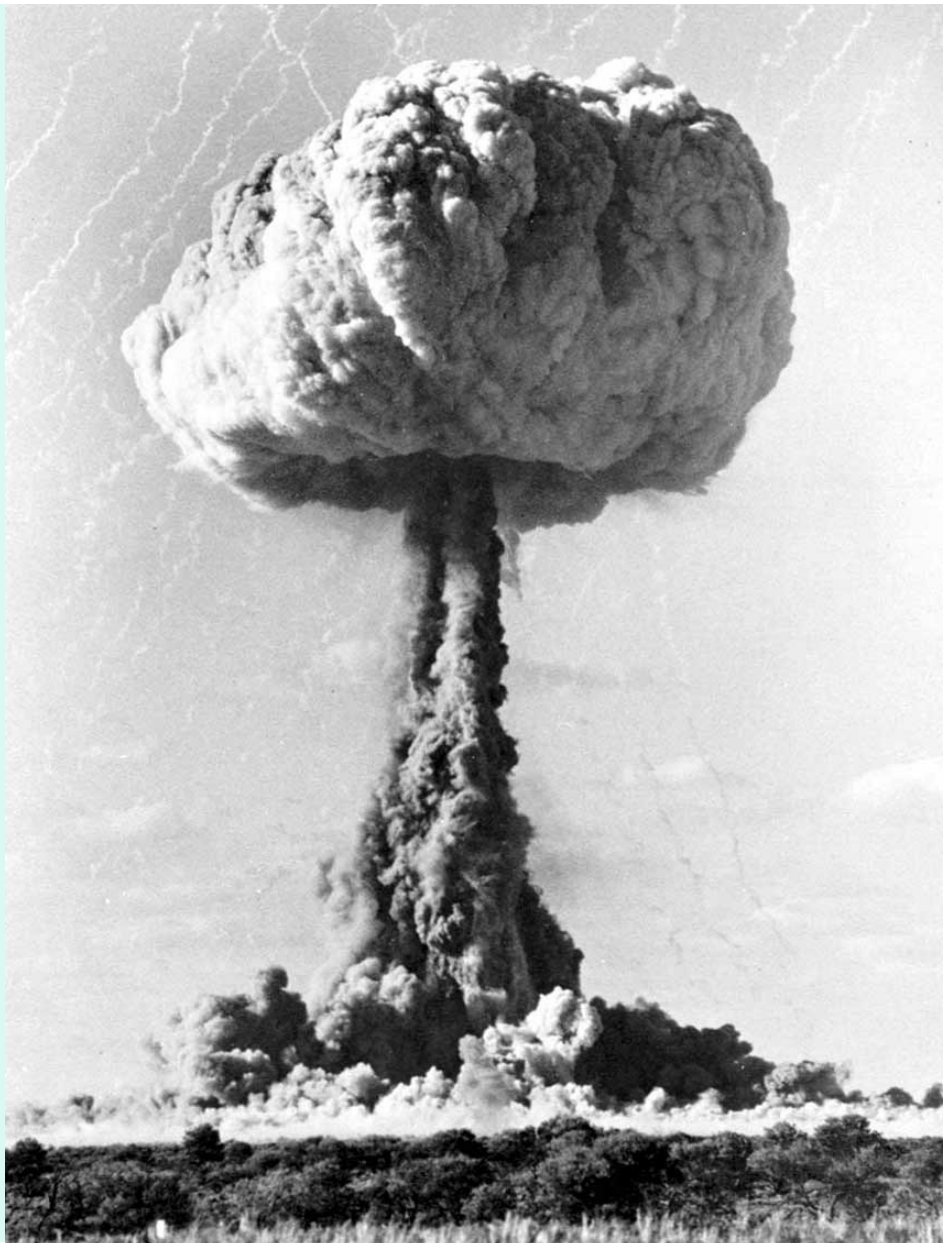
Dose estimates to local populations and critical groups

Weapons' Testing

Information on radionuclide transfer in many different ecosystems

Awareness of the vulnerability of certain semin-natural food chains (Scandinavia)

Focus on the importance of Caesium-137 and Strontium-90



Chornobyl Accident, 1986

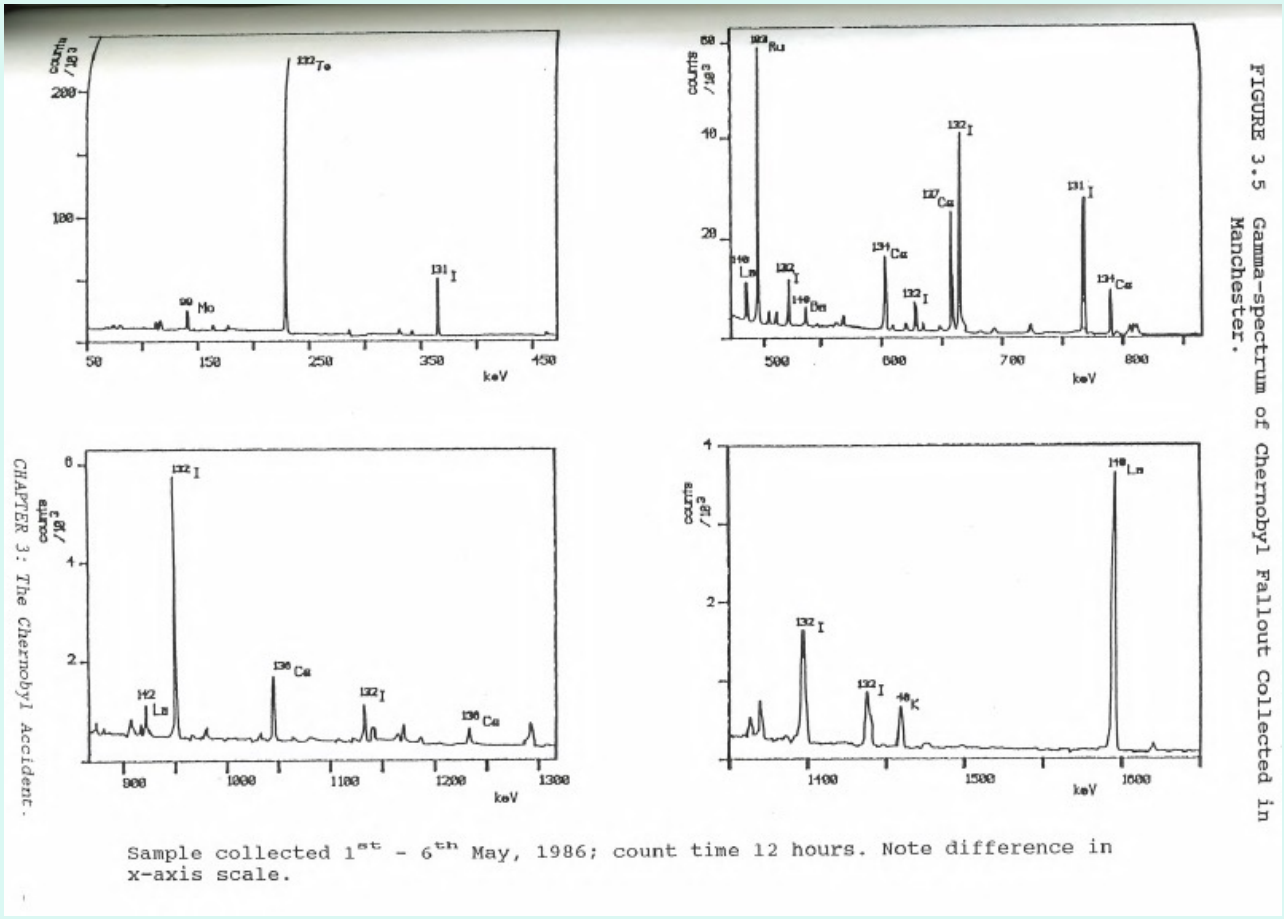
Reactor: Unit 4 of the RMBK Chernobyl Nuclear Reactor

Scenario: Accident occured while staff were conducting an experiment with the reactor. Loss of control lead to a thermal explosion in the core

Release of 300 PBq long-lived radionuclides; death of 31 people (acute); damage to trees; increase in thyroid cancer in children; large scale contamination and long-term environmental effects

Response in the UK

"The potential effects of the (Chernobyl) accident have been assessed and there is no risk to the UK public"
(Hansard UK, May 1986)



Ge-detector gamma spectra – sample collected Manchester University Chemistry Department Roof, 1-6th May 1986

Oughton, D.H 1989, PhD Thesis, University of Manchester

Sheep farmers in UK

Restrictions on movement and sale in sheep in Wales, Cumbria and Scotland for “21 days”

Restrictions and monitoring lasted 26 years in some areas

Considerable hardship for livelihoods already under threat

Concerns about sustainability of small scale sheep farming

Concerns about children staying in farming

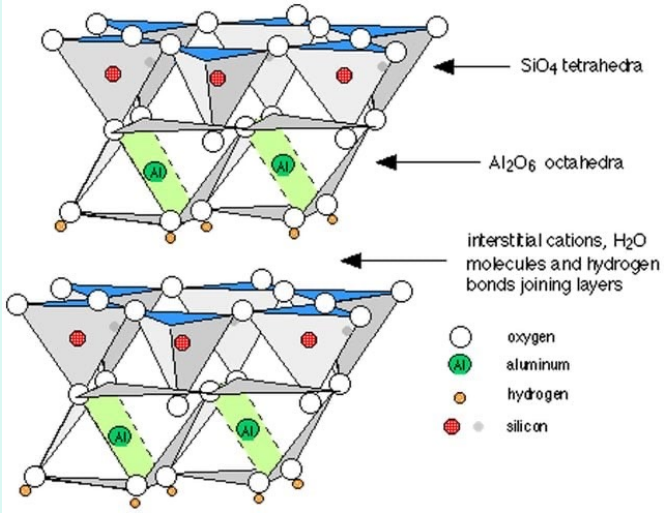
What was forgotten? Chemistry and Ecology

Low binding of caesium in upland soils – low clay levels

Long ecological half-life in upland and semi-natural systems

Too eager to reassure – to tell people not to worry - everything is OK

www.cumbriacommoners.org.uk



Lessons learnt – the importance of speciation

Weathering of uranium oxide fuel particles led to increase in Sr-90 mobility in the Chornobly exclusion zone

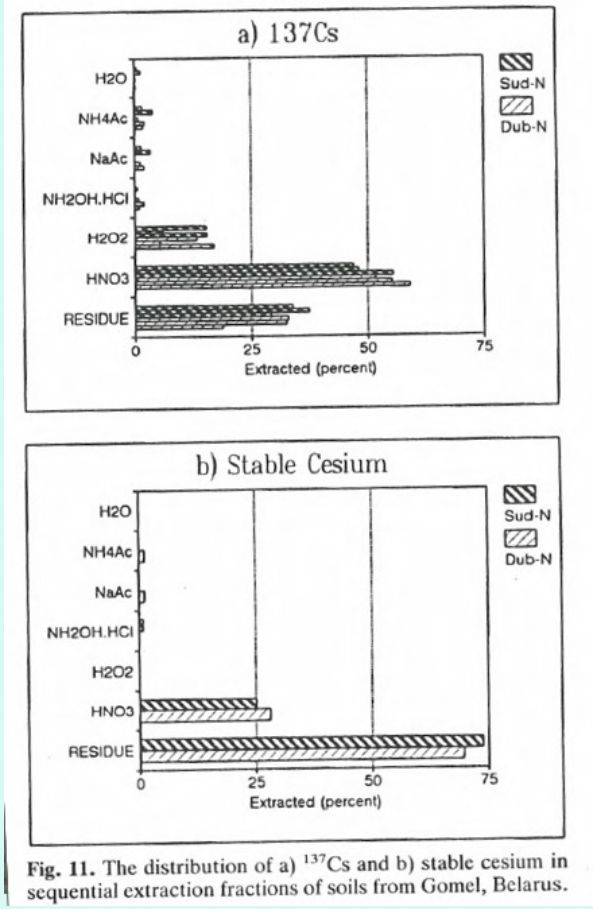


Fig. 11. The distribution of a) ^{137}Cs and b) stable cesium in sequential extraction fractions of soils from Gomel, Belarus.

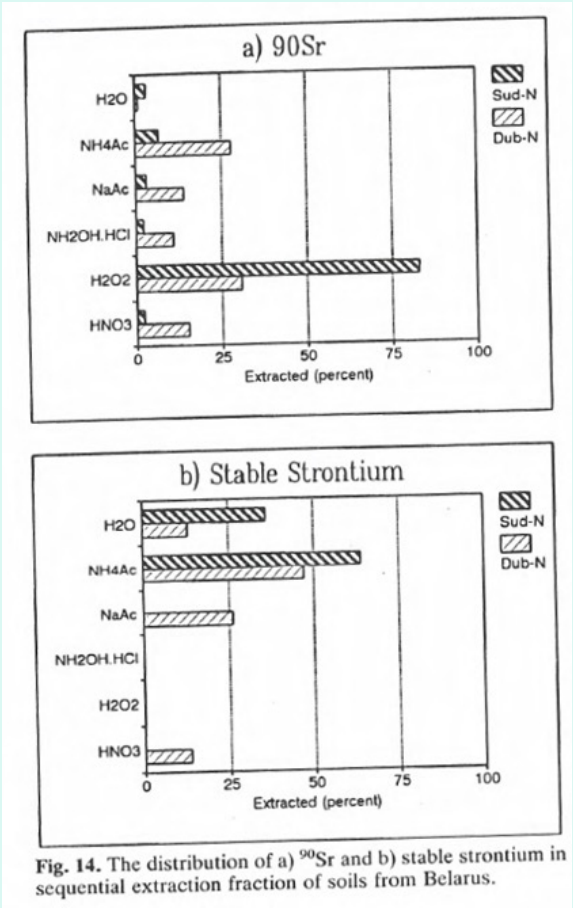
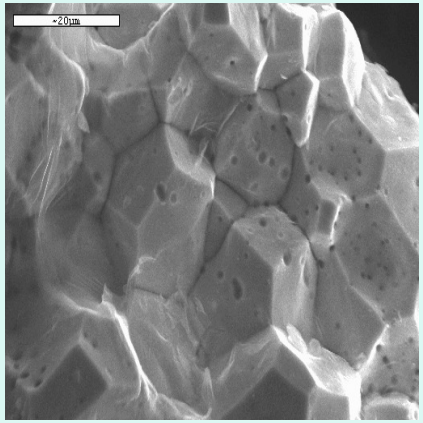


Fig. 14. The distribution of a) ^{90}Sr and b) stable strontium in sequential extraction fraction of soils from Belarus.



The Mobility of ^{137}Cs and ^{90}Sr in Agricultural Soils in the Ukraine, Belarus, and Russia, 1991

Salbu, B.; Oughton, D. H.; Ratnikov, A. V.; Zhigareva, T. L.; Kruglov, S. V.; Petrov, K. V.; Grebenshakikova, N. V.; Firsakova, S. K.; Astasheva, N. P.; Loshchilov, N. A.; Hove, K.; Strand, P.

Health Physics 67(5):p 518-528, November 1994.

Health Phys. 1999 Mar;76(3):251-9. doi: 10.1097/00004032-199903000-00006.

Kinetics of fuel particle weathering and 90Sr mobility in the Chernobyl 30-km exclusion zone

V A Kashparov [1], D H Oughton, S I Zvarich, V P Protsak, S E Levchuk

Lessons learnt – the importance of talking to affected people

“We may be on the eve of a new age of enlightenment. When a scientist says he doesn't know, perhaps there's hope for the future!”

See, Wynne, Brian. «Misunderstood Misunderstandings» 1989, PUS ; or «May the sheep safely graze» 1996

Lessons learnt – the importance of protective measures

Lessons learnt – the human dimensions of the accident

Psychosocial consequences

Loss of livelihood

Change in demographics

Fear of stigma and discrimination

Loss of a normal way of life

Loss of connection to childhood places

UNDP 2002, The Human Consequences of the Chernobyl Nuclear Accident

Lessons learnt – the importance of monitoring and self-help actions

Lavrans Skuterud, NRPA

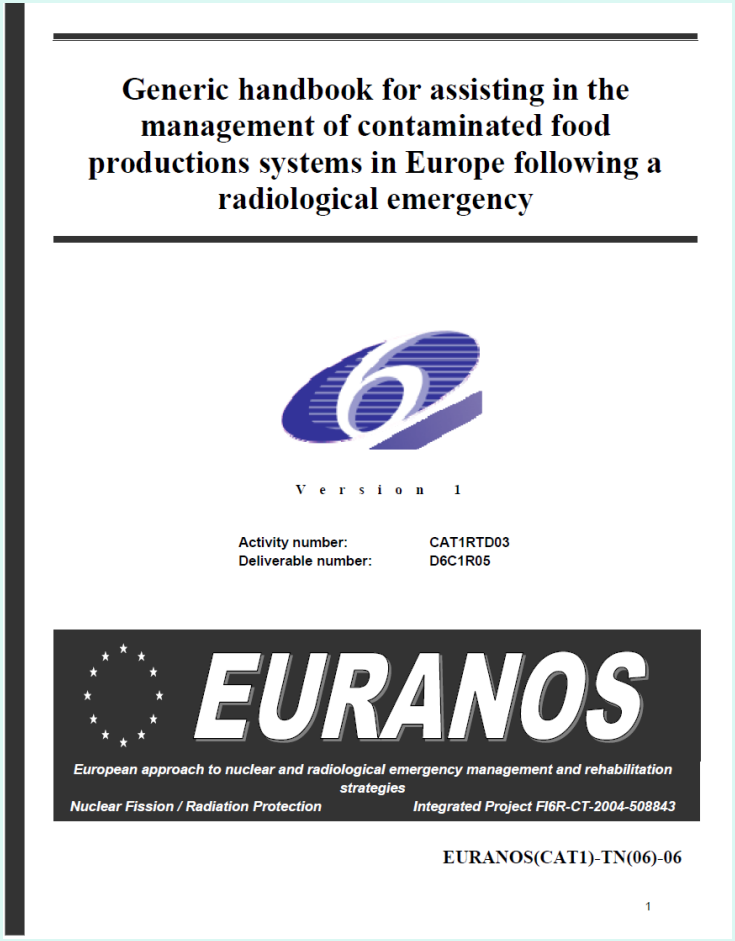
Multi-disciplinary projects assessing emergency preparedness and radiation accident management strategies.

STRATEGY, EURANOS, CONFIDENCE and NERIS EU Projects

STRATEGY project (Sustainable Restoration and Long-Term Management of Contaminated Rural, Urban and Industrial Ecosystems). 1999-2003.

Outputs: Transport models, countermeasure and remediation templates, handbooks; stakeholder consultation, decision-tools,

See www.strategy-eu.org.uk and www.neris-eu.com


Generic handbook for assisting in the management of contaminated food productions systems in Europe following a radiological emergency

Version 1

Activity number: CAT1RTD03
Deliverable number: D6C1R05

EURANOS

European approach to nuclear and radiological emergency management and rehabilitation strategies

Nuclear Fission / Radiation Protection Integrated Project FI6R-CT-2004-508843

EURANOS(CAT1)-TN(06)-06

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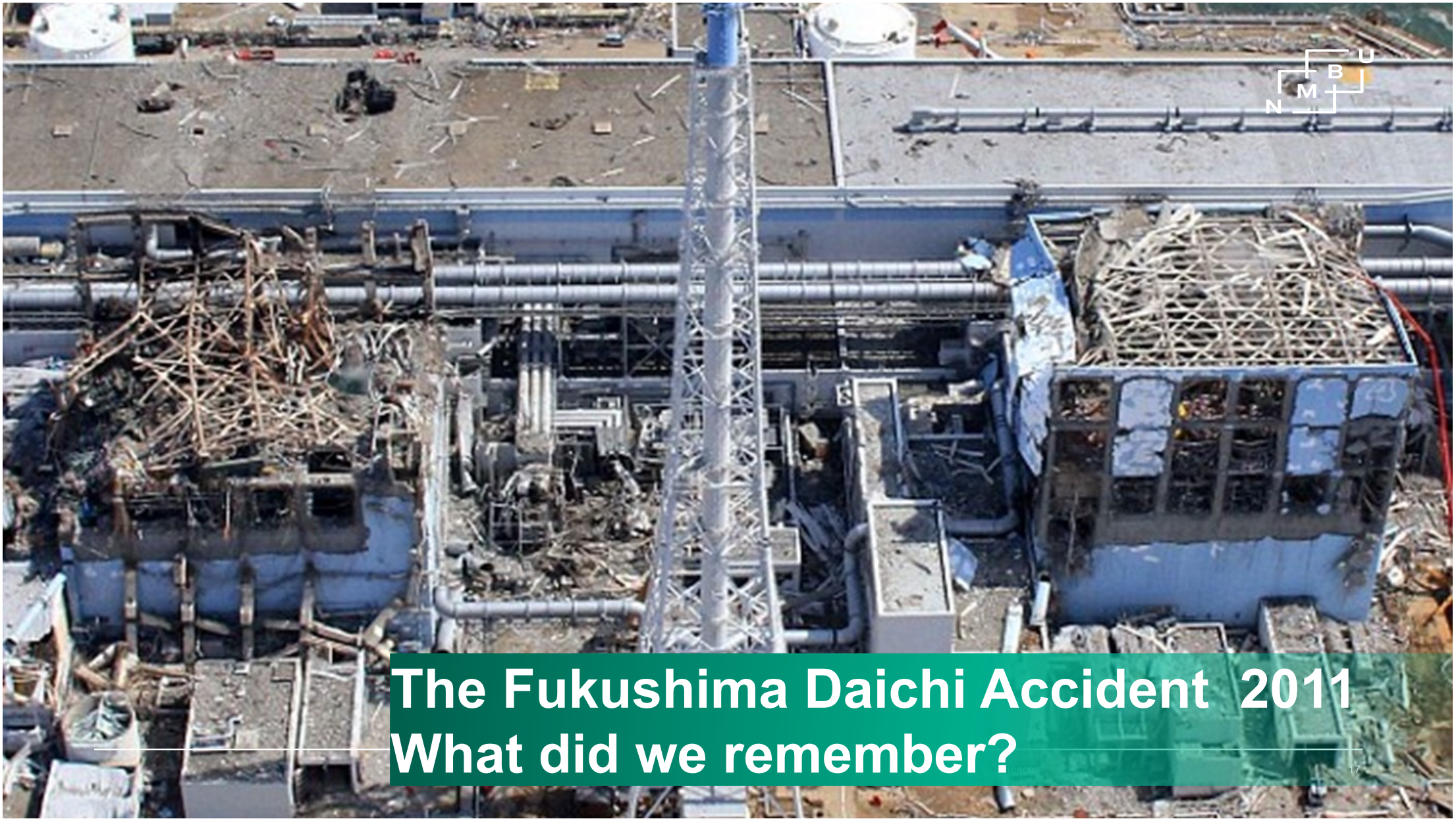
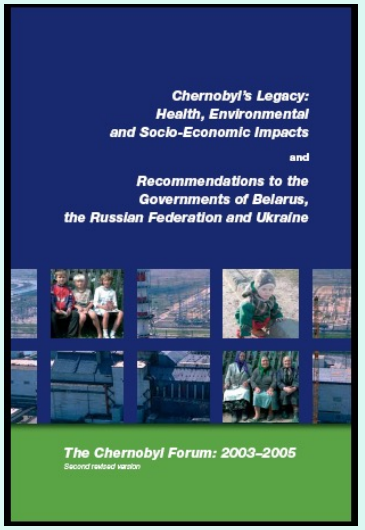


The Fukushima Daichi Accident 2011
What did we remember?

Psychosocial Consequences of Radiation Accidents

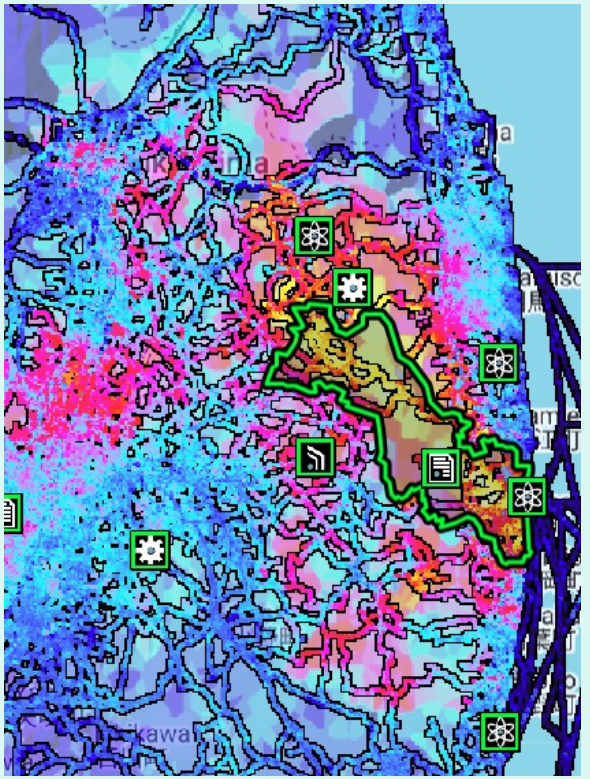
"*The social and psychological consequences of Chernobyl far outweigh any direct heath effects from radiation exposure*" (IAEA, 1991, + +)

"*The most important health effect is on mental and social well-being, related to the enormous impact of the earthquake, tsunami and nuclear accident, and the fear and stigma related to the perceived risk of exposure to ionizing radiation*" (UNSCEAR, 2013)



The Importance of Monitoring

Personal dosimeter: D-Shuttle



map.safecast.org

… but not always without controversy : Thyroid Screening

In Iwaki, a town south of the Fukushima nuclear plant, a doctor conducts a thyroid examination on 4-year-old Maria Sakamoto. Scientists are puzzled over a high number of thyroid abnormalities observed so soon after the accident.

© Toru Hanai/Reuters

Mystery cancers are cropping up in children in aftermath of Fukushima

By Dennis Normile | Mar. 4, 2016 , 10:45 AM

Science

Recommendations and procedures for preparedness and health surveillance of populations affected by a radiation accident

SHAMISEN
Nuclear Emergency Situations Improvement of Medical and Health Surveillance

OPERA
OPEN PROJECT FOR EUROPEAN RADIATION RESEARCH AREA

European Commission

What was forgotten/overlooked?
Lack of preparedness

Courtesy K Tanigawa.

Conservative dose estimates …

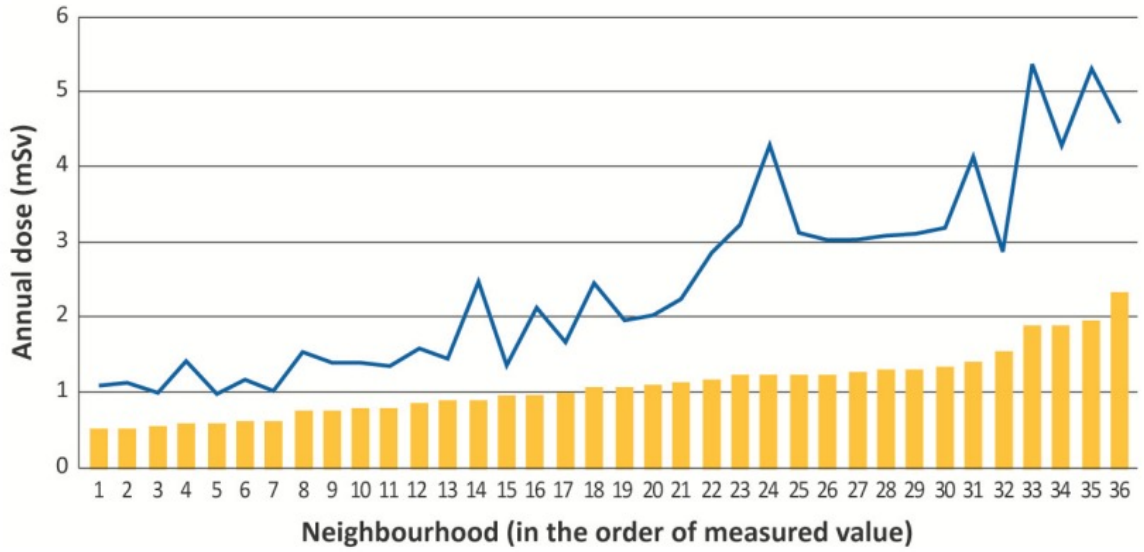


FIG. 4.2–14. Comparison of external individual dose estimates with measurements in Date City between July 2012 and June 2013. The effective doses are assessed by estimation (line), assuming indoor occupancy and shielding for 16 h, outdoors for 8 h, and by personal monitoring (bar) of personal dose equivalent, in various neighbourhoods of the city (numerated) [219].

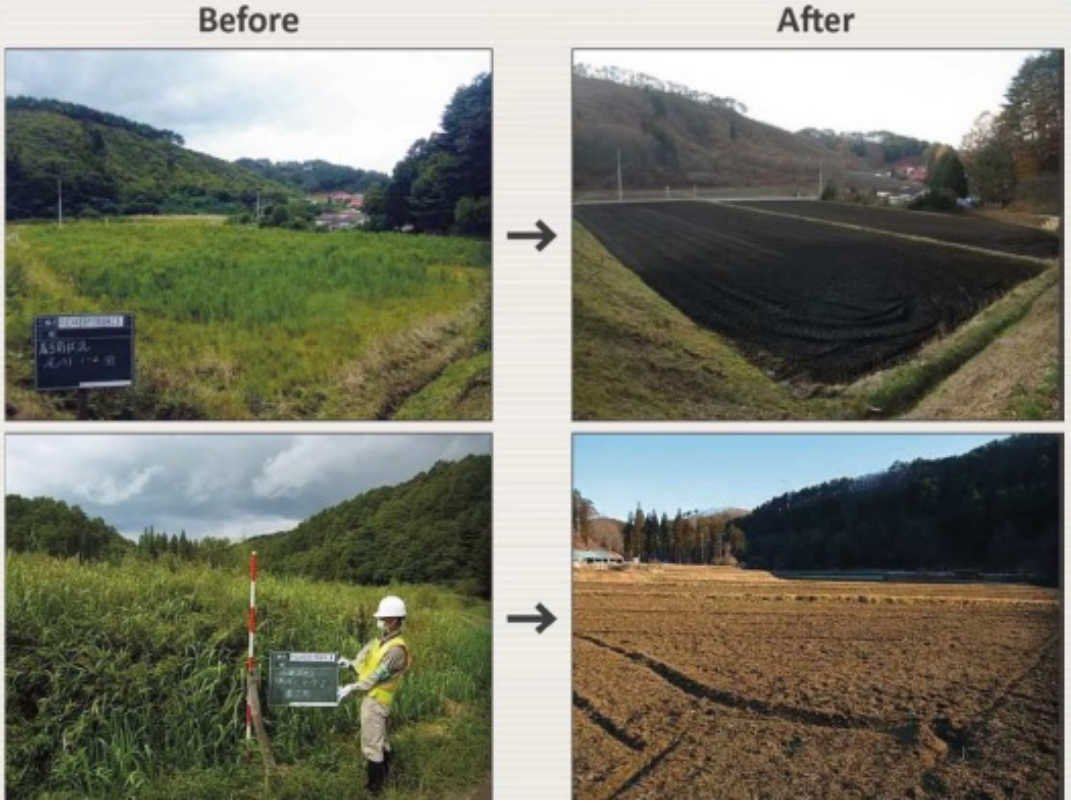
IAEA, 2017

… underestimating the side effects of protective measures

- Washing buildings
- Removal of topsoils
- Restrictions on food sale and distribution
- Food monitoring

The side effects of protective measures

Landscapes before and after remediation in Tamura City.



Changing permitted levels in foods

Initial permitted level 500 Bq/kg

Reduced to 100 Bq/kg 1. April 2012

Did that help???

Other possible talking points

«Don’t worry» - everything will be returned to how it was

Compensation issues

Challenges with dose levels

Extended relocation


Thank you!
"Those that fail to learn from history, are doomed to repeat it."
Winston Churchill