Remediation after the Fukushima Daiichi accident

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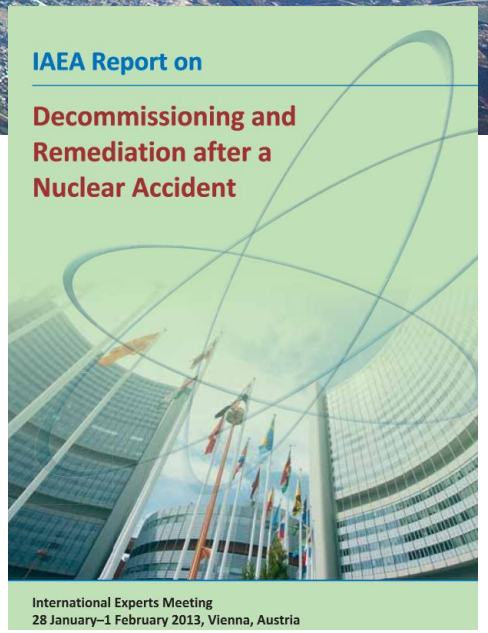
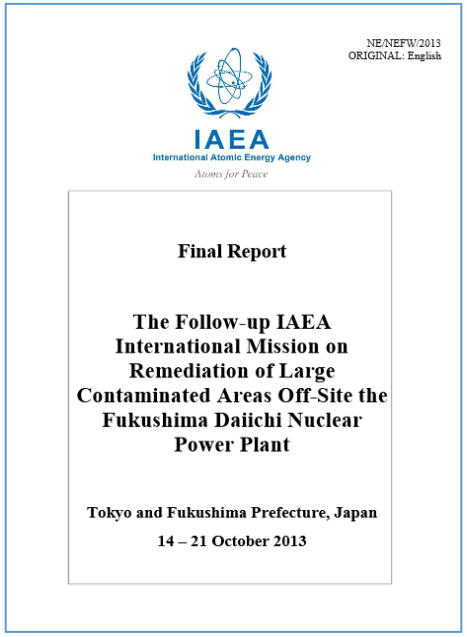
Outline

- Radioecology
- Remediation
- Remediation after the Fukushima accident
- Estimation of doses
- Setting case specific remediation action levels
- Waste generation and management
- Summary





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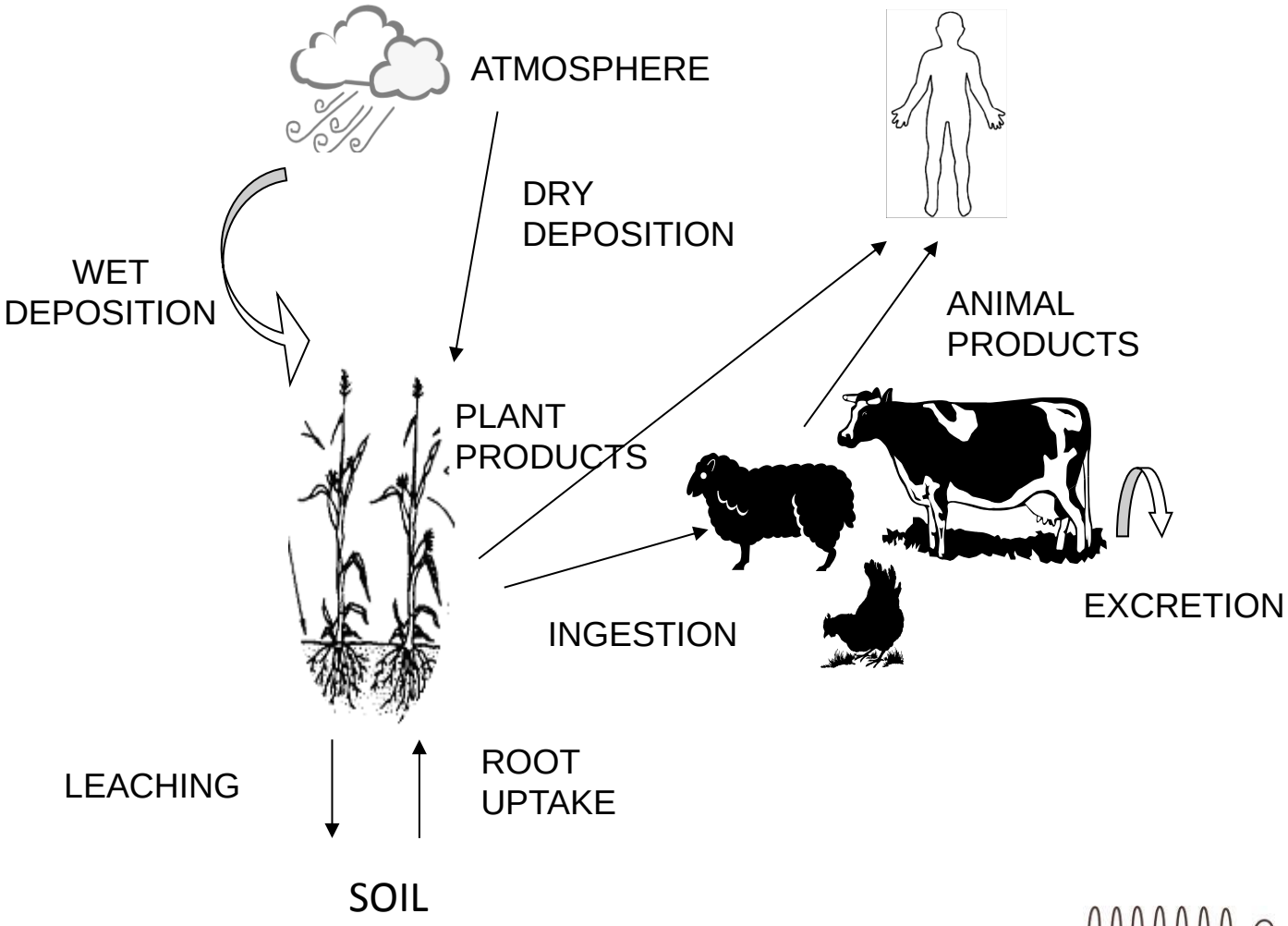
Radioecology: eg: Main terrestrial pathways



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Wildlife

Chernobyl zone: TREE project photos

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What is remediation

IAEA Safety Glossary:

".. any measures that may be carried out to reduce the radiation exposure from existing contamination of land areas through actions applied to the contamination itself (the source) or to the exposure pathways to humans".

World Health Organization defines health as

- "… a state of physical, mental and social well-being".

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Remediation and recovery objectives

- Reduction of dose
- A return to normal life and livelihoods

Evacuate zone around Fukushima Daiichi NPP

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Principles For Remediation

- Justification for undertaking remediation
- Optimisation of protection through application of remedial actions
- Limitation of radiation doses
- Protection for both humans and the environment
- Targeting use of resources efficiently
- Ensuring open and transparent communication with stakeholders

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Remediation Strategy

- Sets out the means for achieving the principles and requirements set out in the national policy
- Normally established by the relevant remediation implementer or by government

Remediation After The Fukushima Accident

- Strategy applied in Japan includes the ICRP and IAEA dose criterion [reference level of annual additional effective dose 1-20 mSv]
- stepwise and rapid reduction in total doses in residential areas and farmland
- Long term goal - additional annual effective dose shall be 1 mSv or less
- Most of the dose from external dose pathways from 2012 onwards

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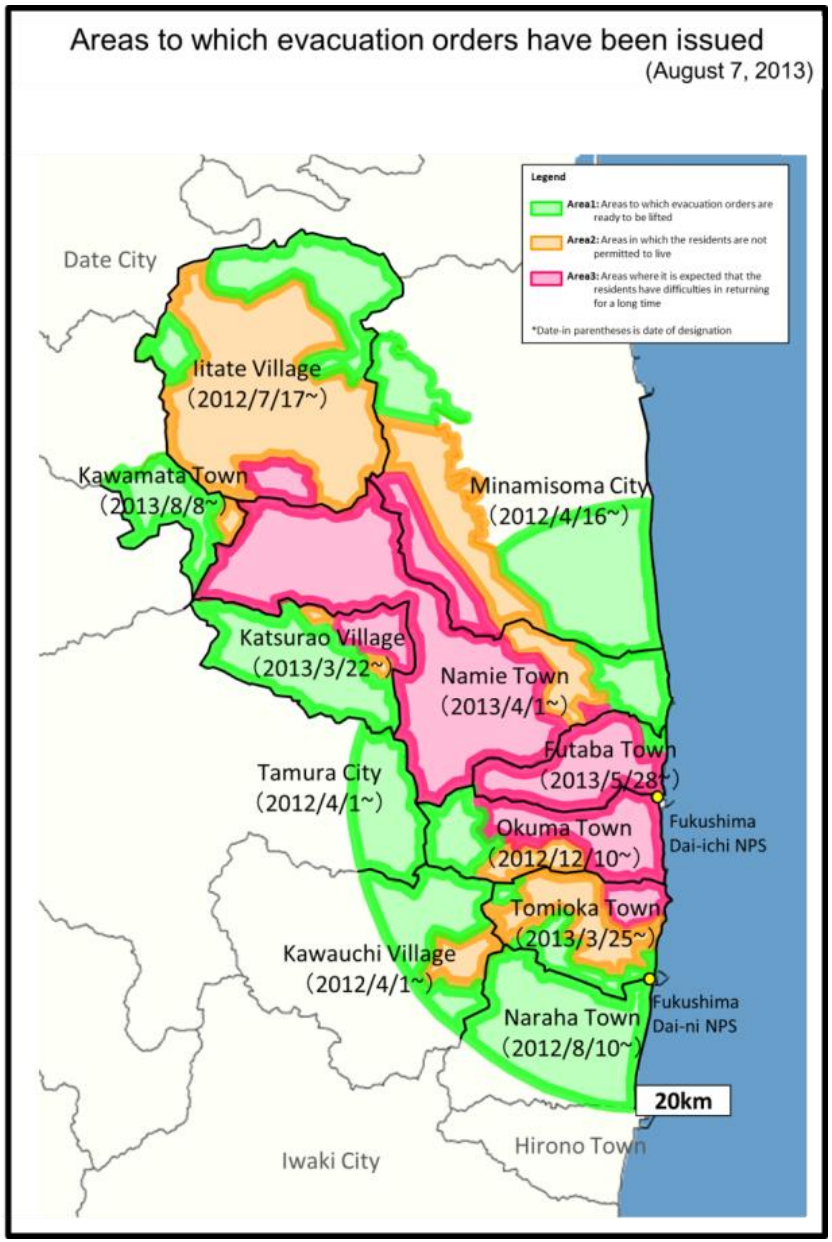
Special Decontamination Area (SDA)



- previously restricted areas
- deliberate evacuation areas
- additional annual effective dose for individuals anticipated >20 mSv during the first year
- National Government

IAEA 2013 Follow up mission

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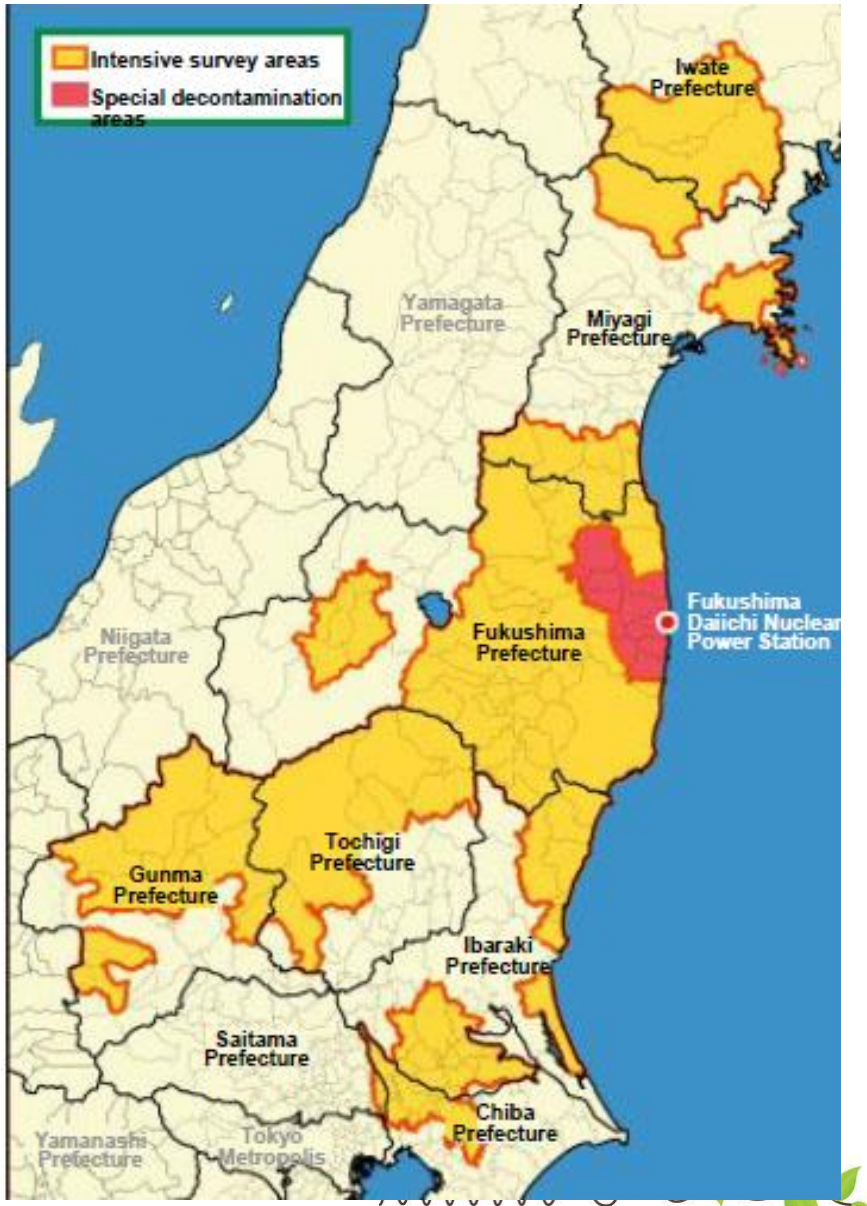
Intensive Contamination Survey Area (ICSA)

- additional annual effective dose between 1 -20 mSv estimated in some parts of the municipality
- areas where air dose rate > 0.23 µSv/h designated "Decontamination Implementation Areas".
- Municipalities



IAEA 2013 Follow up mission

Estimation Of Doses

- Estimation of additional annual effective dose to individuals used to define the designated areas for remediation were deliberately conservative and based on the concept of the critical group
- an ambient dose rate of 0.23 µSv/h assumed to correspond to an additional annual effective dose of 1 mSv.

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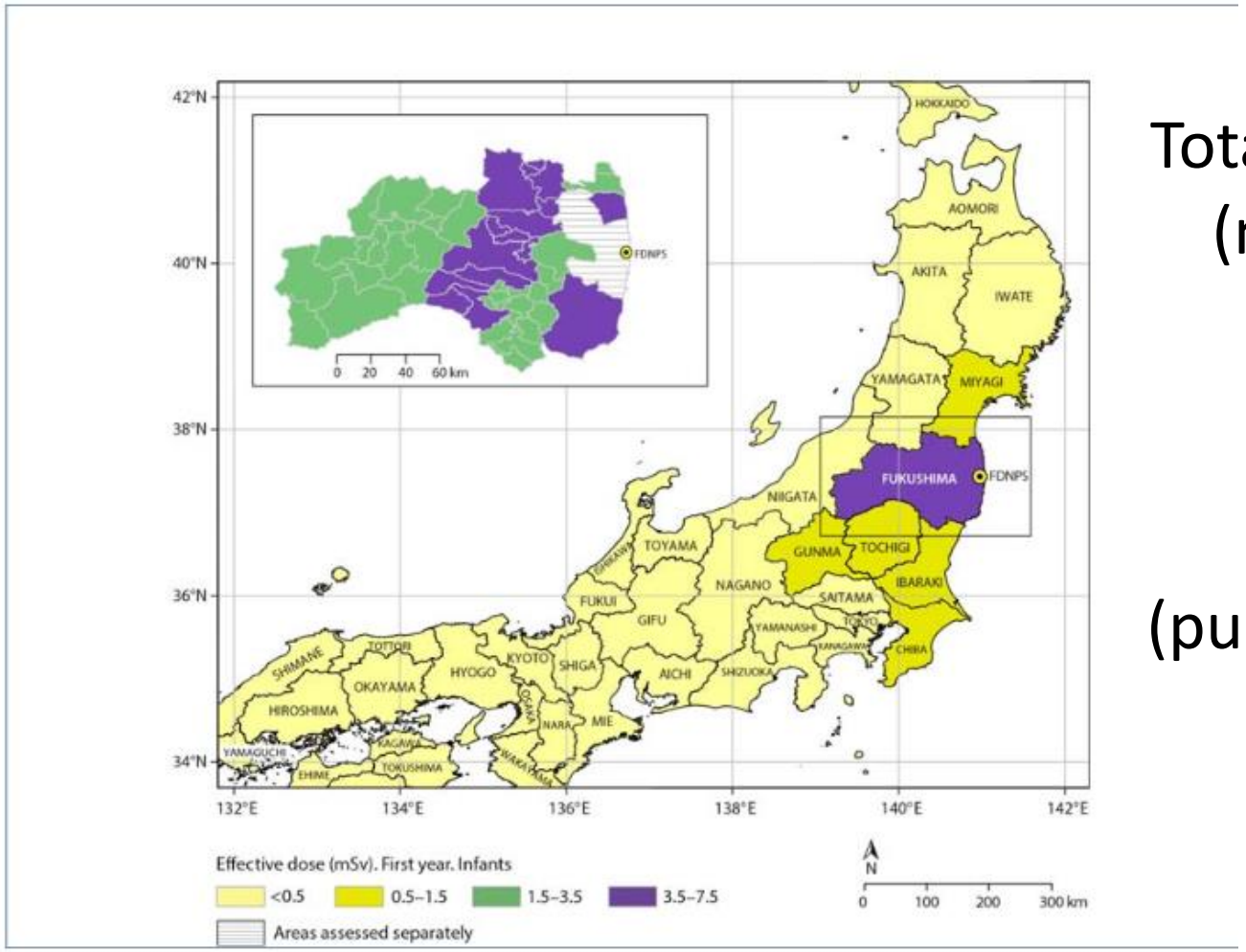
Estimation Of Doses

- ICRP quantitatively defined the representative person as a virtual person receiving an average dose from the upper 10% of the population dose distribution
- areas of land (especially ICSA) designated for remediation where average additional annual effective doses are < 1 mSv from 2012

Predicted doses to infants



Total effective doses (mSv) to infants in first year

UNSCEAR 2014

(purple 3.5-7.5 mSv)

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Food action levels

Animal product	Action levels for radiocaesium in feed [Bq/kg fw]
Cattle	100
Pigs	80
Chickens	160
Cultured fish	40

with 80 % water content basis for forage, and FW basis for other feeds

Japanese Ministry of Agriculture, Forestry and Fisheries

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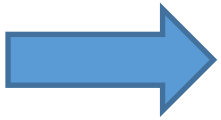
Challenge - Solution

- Reference levels often set in emergency phase
- Large uncertainty when initially estimating doses and insufficient site-specific info



HIGHLY CONSERVATIVE

- Develop models for the estimation of internal and external dose using country-specific data as part of emergency preparedness.
- Derivation of case specific remediation action levels such as air dose rates before an accident

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Setting Case Specific Remediation Action Levels

- Many factors affect effective dose received - RADIONUCLIDE, ENVIRONMENT, LAND USE, LIVING HABITS – and are site specific
- Derived case-specific remediation action levels are a practical solution which should be site-specific and transparently estimated

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Identifying Key Pathways

Measurement and characterisation

- In post accident phase BOTH deposition density and environmental characteristics important
- Most key exposure routes and areas giving higher doses will be identified quickly BUT not all

→ LOSS OF TRUST

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Preparedness

Availability / use of measurement devices critical for implementing policy and strategy

Koshiabura

Steep forested catchments

Identify potentially radioecologically sensitive pathways / regions BEFORE an accident

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Identifying, evaluating, implementing Remediation

Remedial measures need to be considered for:

- Effectiveness
- Feasibility
- Practicality
- Costs
- Wastes
- Side effects
- Social aspects
- Experience

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STRATEGY / EURANOS

- Guidance documents and datasheets
- Focused on European conditions
  - agricultural, climate, cultural
- NOT intended to be site specific
- Inadequate detail for implementation
- Some confusion in management options

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Constraints:
•Legal constraints
•Social constraints
•Environmental constraints
•Communication constraints
Effectiveness:
•Countermeasure effectiveness
•Factors influencing effectiveness of procedure (Technical)
•Factors influencing effectiveness of procedure (social)
Feasibility:
•Required specific equipment
•Required ancillary equipment
•Required utilities and infrastructure
•Required consumables
•Required skills

•Required safety precautions
•Other limitations
Waste:
•Amount and type
•Possible transport, treatment and storage routes.
•Factors influencing waste issues
Doses:
•Averted dose
•Factors influencing averted dose
•Additional dose
Intervention costs:
•Equipment
•Consumables
•Operator time
•Factors influencing costs

•Communication costs
•Compensation costs
•Waste cost
•Assumptions
Cost-effectiveness:
Side-effect evaluation:
•Ethical considerations
•Environmental impact
•Agricultural impact
•Social impact
•Other side effects, pos. or neg.
Stakeholder opinion
Practical experience
Key references
Comments

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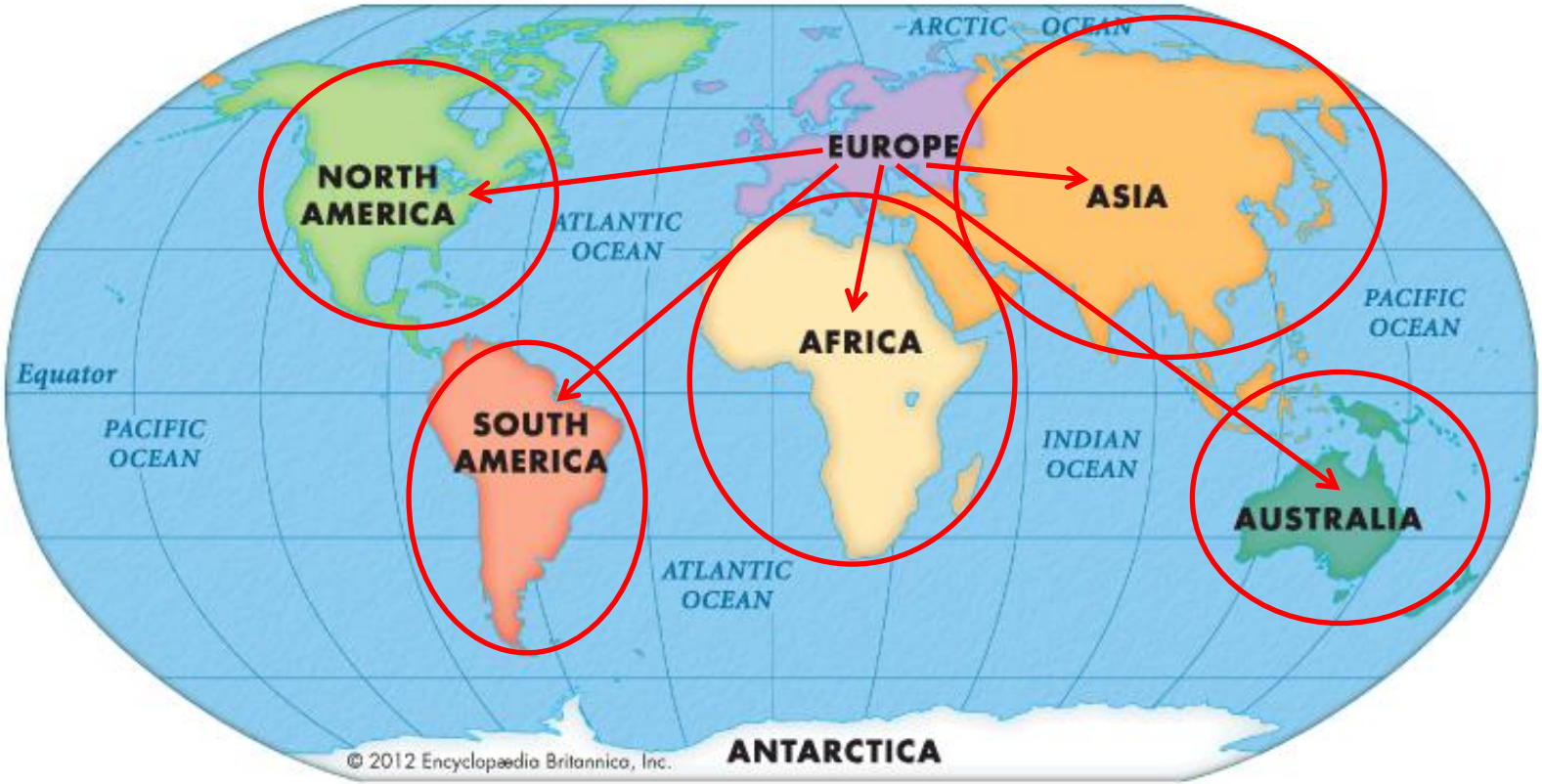
Relevance?



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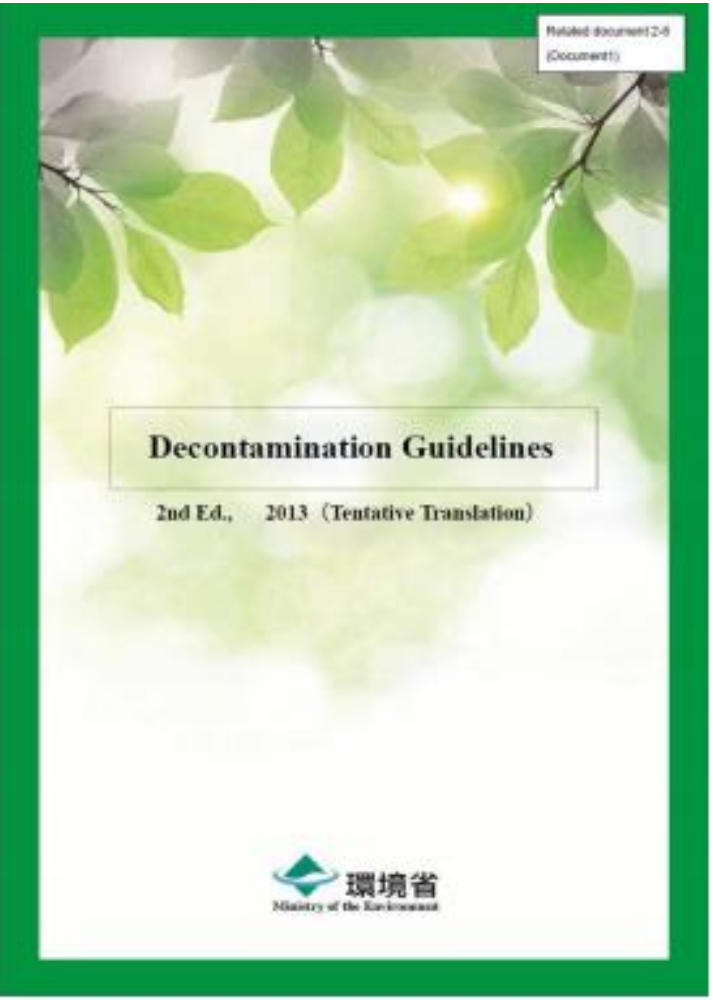
Pilot demonstration projects



- Provided training and experience in site specific decontamination
- Facilitated the development of guidelines for carrying out decontamination activities
- Facilitated development of procedures for ensuring worker safety.
- Involved stakeholders which helped promote understanding and acceptance of remedial actions

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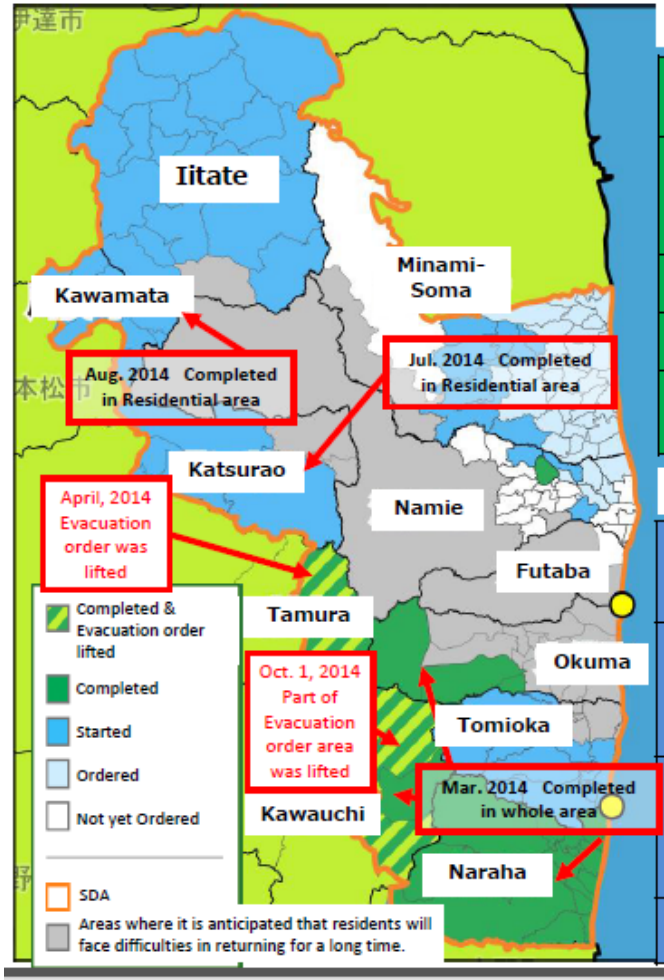
Commonly used remediation measures

Target	Remediation measures
Houses, buildings	• Removal of deposits from the roof, deck and gutters • Wiping roofs and walls • Stripping paint • Dust vacuum sanding • High-pressure washing
Schoolyards, gardens and parks	• Topsoil removal • Weed / grass / pasture removal
Roads	• Removal of deposits in ditches • High-pressure washing
Gardens and trees	• Mowing • Removal of fallen leaves, • Topsoil removal • High pressure washing • Whittling of surface contamination
Farmlands	• Reversal tillage • Soil suspension in water and removal – paddy fields • Topsoil removal • Soil treatment • Soil hardening and removal • Weed / grass / pasture removal
Animal production Forests and woodland	• Control radiocaesium levels in animal feed • Removal of fallen leaves and lower twigs • Pruning

Remediation progress in SDA

Progress in the Special Decontamination Area ②
(as of Dec., 2014)



Completed decontamination

Tamura	Whole area decontamination was completed in June, 2013. Evacuation order was lifted on April 1, 2014
Kawauchi Naraha Okuma	Whole area decontamination was completed in March, 2014 ※ As for Kawauchi, a part of the evacuation order was lifted on October 1, 2014
Katsurao	Decontamination of residential area was completed in July,2014
Kawamata	Decontamination of residential area was completed in August,2014
Joban Expressway	Decontamination was completed ※ Reopened between Hirono and Joban-Tomioka on Feb. 22, 2014 ※ Opened between Namie and Minami-Soma on Dec. 6, 2014

Schedules of decontamination ahead

Kawamata Katsurao	Aiming at the completion of decontamination of remaining areas within 2015
Iitate	Aiming at the completion of decontamination of residential area within 2014 and the completion of decontamination of remaining area within 2016
Minami-soma Namie Tomioka	Aiming at the completion of decontamination of residential area within FY 2015 and the completion of decontamination of remaining area within FY 2016
Futaba	Aiming at the completion of decontamination within FY 2015

MOE 2015 http://josen.env.go.jp/en/pdf/progressseet_progress_on_cleanup_efforts.pdf?150113

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WASTE GENERATION AND MANAGEMENT

Decontamination of surfaces and topsoil

- Reduces external exposure
- High acceptability and feasibility
- Protects economic value of residences and land
- Well received by residents

- High logistical needs
- Large generation of waste
- High cost
- Averted dose less than air dose reduction at 1 m
- Averted dose can be small

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Waste generation and management

Prior thought to regulatory, management and practical application issues relevant to waste

- Generation
- Minimisation
- Incineration
- Disposal
- Cost

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Challenges for remediation - dosimetry

Conservatism

Developing accurate site specific external dose measurement
Setting case-specific remediation action levels
Measuring “realistic” individual doses of returnees

Enhance Reliability of dose assessments and predictions

Identification of hot spots
Readily available, fast, simple measurements
Robust devices
Automated, online measurements

Optimisation

Tailoring remediation to site specific conditions

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Summary

- Broad objectives of remediation need to be addressed
- Site specific data needed
- Emergency preparedness needs to include the post accident phase / remediation
- Need to retain knowledge and expertise, and promote knowledge transfer from countries with practical experience
- Revise international guidance

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