10 Years of Remediation Efforts in Japan

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Acknowledgements

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Disclaimer

The views expressed in this presentation are those of the author and do not necessarily represent the views or the policies of the U.S. Environmental Protection Agency.

Outline

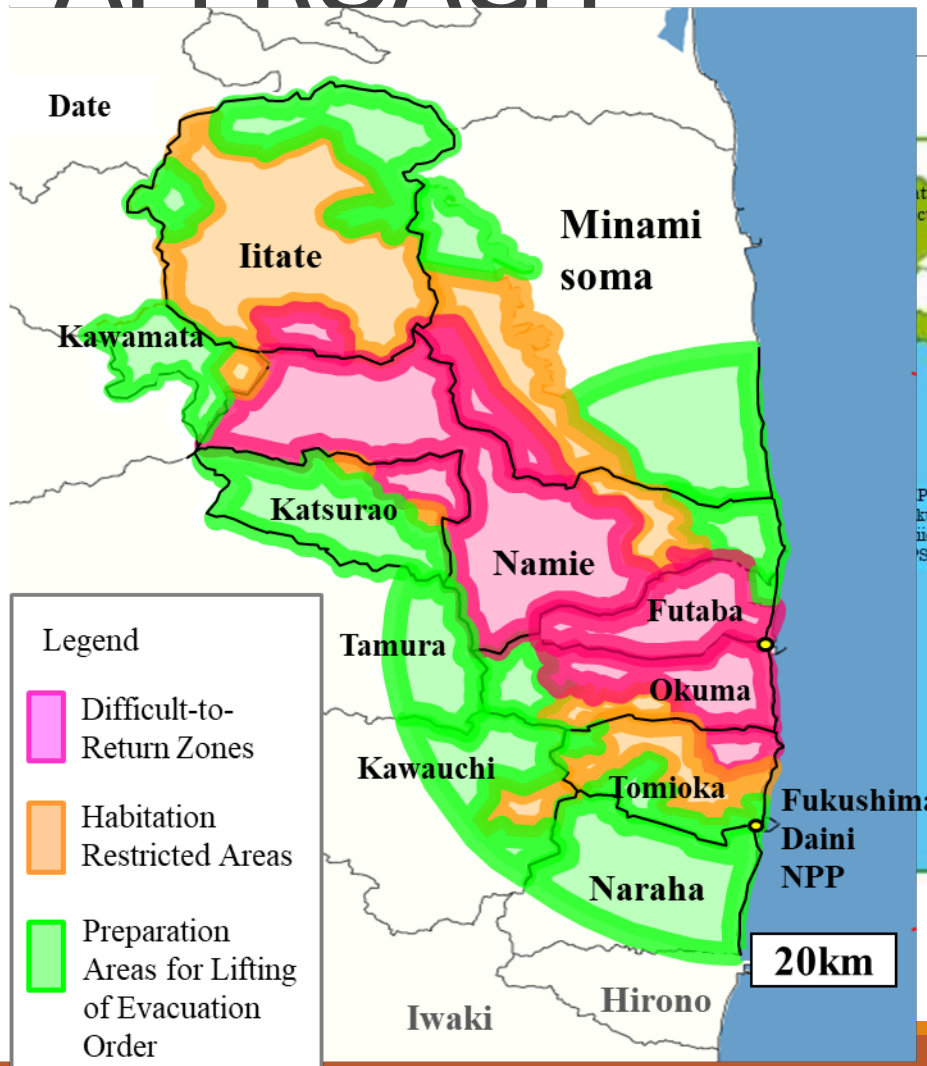
Environmental Remediation

- Preparation
- Implementation
- Results
- Follow-up Remediation
- Verification of Remediation

Lessons Learned

Messages for Responders and Decision Makers

ENVIRONMENTAL REMEDIATION APPROACH



- Target: additional exposure dose of 1 mSv/a or less
- Special Decontamination Area (SDA): evacuation area, remediation by the Ministry Of Environment
- Intensive Contamination Survey Area (ICSA): additional external exposure dose rate exceeds 1 mSv/year, not evacuated, remediation by each municipality
- In March 2018, remediation completion except the Difficult to Return Zone (expected annual radiation level is higher than 50 mSv)

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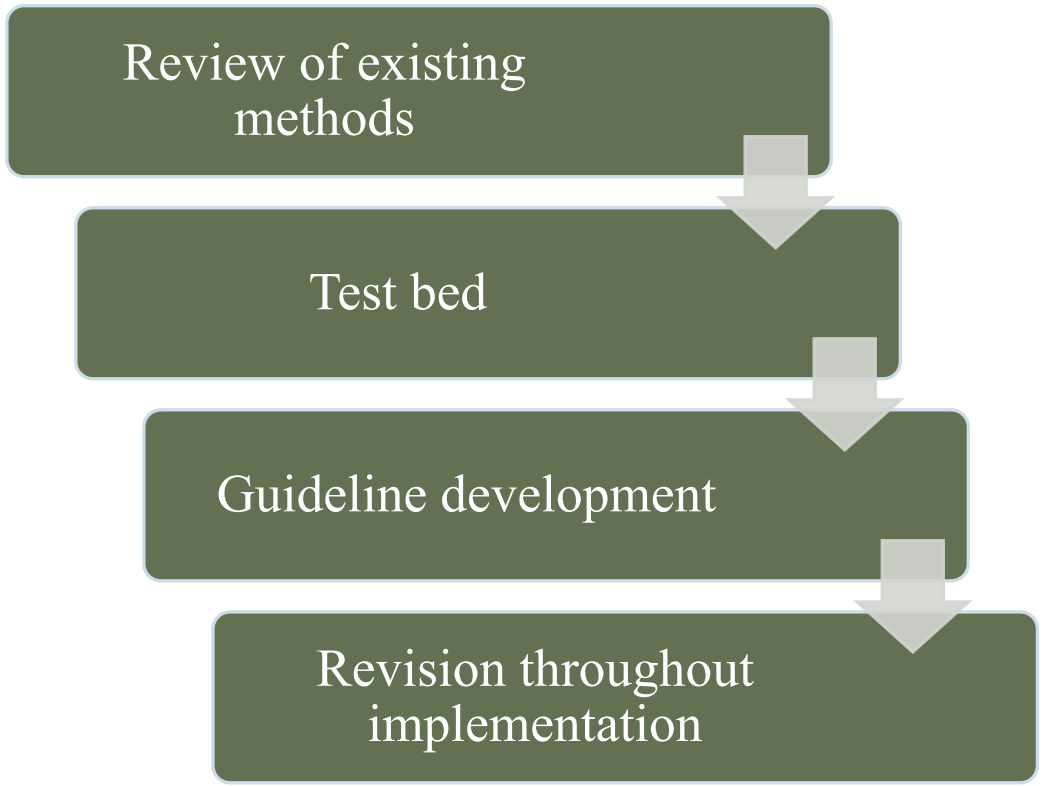
SUMMARY OF TEPCO AND GOVERNMENT PRACTICAL ROLES IN REMEDIATION

Area	TEPCO	Central Government (MOE)	Fukushima Prefecture	Municipality
SDA	Payment for the expense of remedial actions; Cooperation with remediation projects (e.g., dispatching the employees in response to the request)	Funding, remediation plan and implementation, worker training, regulation, policy, information distribution	Cooperation with the national policy as a liaison between central government and municipalities; Information distribution cooperatively with central government	Direct communication with evacuees; Support MOE for remediation plan and implementation, landowner identification and coordination of meetings; remediation information distribution to evacuees, coordination for lifting of evacuation orders and remediation verification committee meetings
ICSA	Same as SDA	Funding, review and approval of remediation plans, technical supports to Prefecture government (information and experts)	Management of the fund for the remediation, technical supports to municipalities (information and experts), prefecture facility remediation	Planning and implementation of remediation and information distribution

REMEDIATION PREPARATION



Summarized steps to identify and implement remediation methods

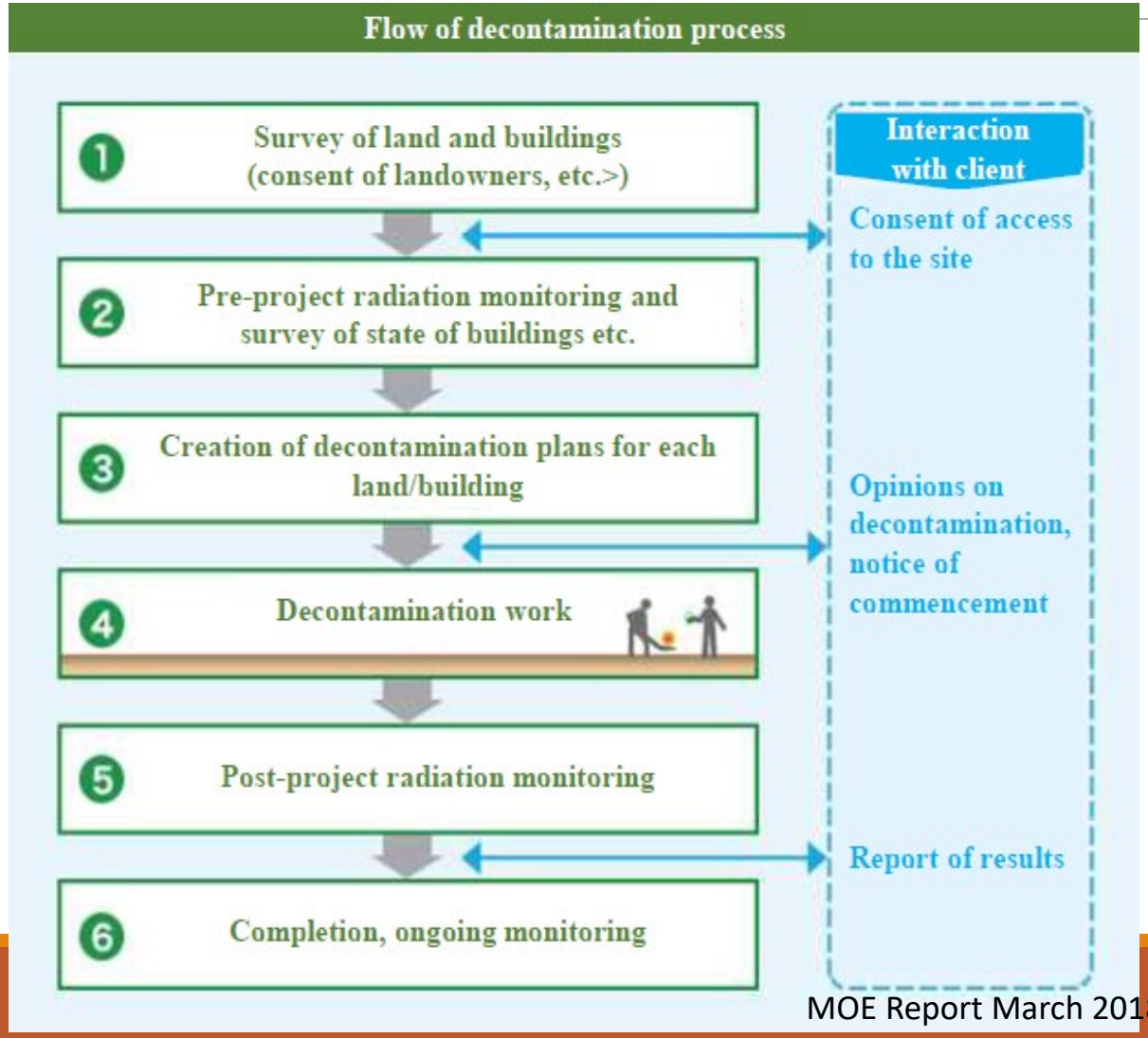
Identification of remediation methods

- MOE's Decontamination Guidelines

Remediation workers and equipment

- Leveraging ordinary public work project system and experiences
- Addition of radioactive material handling and remediation work

REMEDIATION IMPLEMENTATION OVERVIEW



- SDA by MOE: Decontamination Model Projects, preliminary remediation, whole area remediation, follow-up remediation
- ICSA by municipalities: remediation plan (Decontamination Guidelines), MOE review, implementation
- Stakeholder involvements throughout the process

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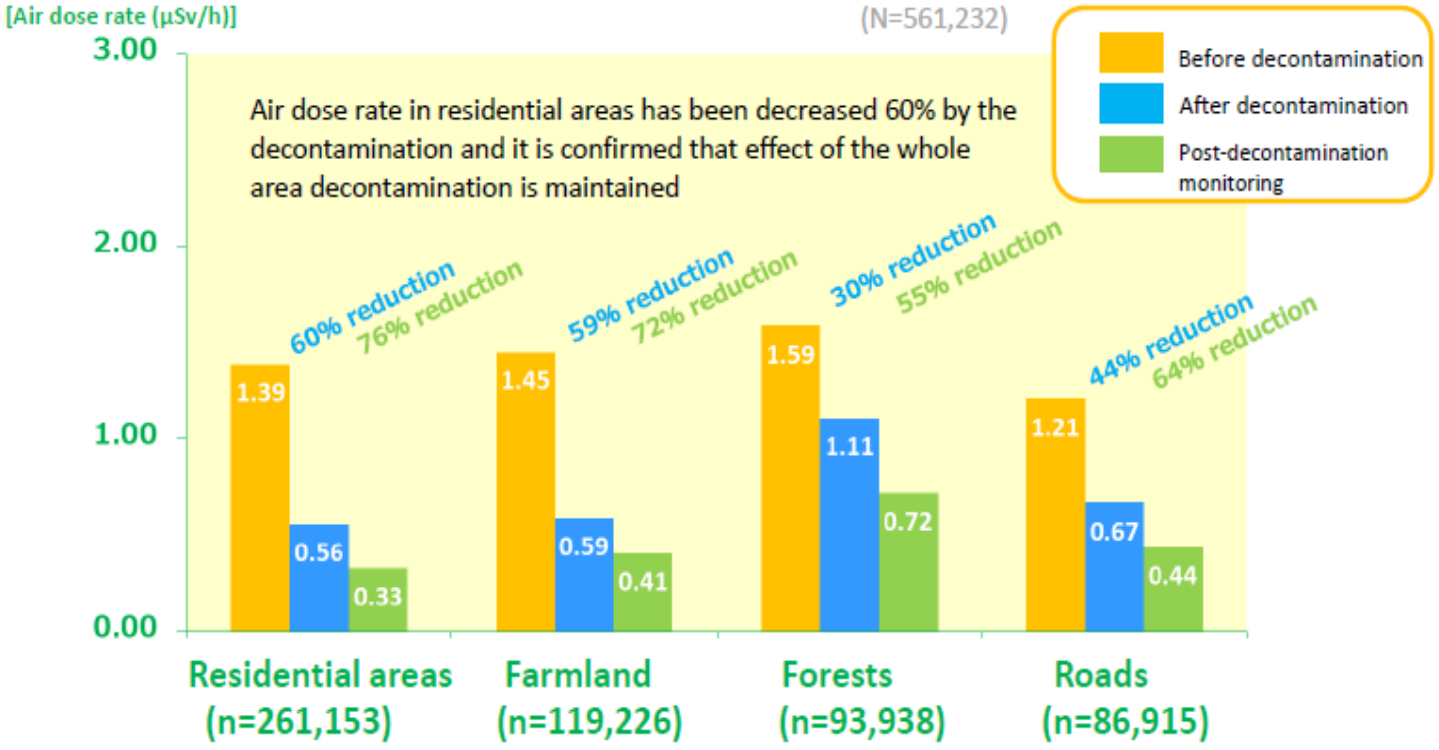
REMEDIATION PRINCIPLES

- From high to low location
- Hot spots first
- Low waste volume methods

Surface removal	Roof	Wall	Lawn
Low ⇩ High	Removal of deposits Wiping Brushing	Removal of deposits Wiping Brushing	Removal of deposits Weeding, lawn mowing Deep cutting of turf Grass stripping

RESULTS OF WHOLE AREA REMEDIATION: SDA

<Air dose rate measured at the height of 1m from the ground / Transition according to land category>



NOTE: The chart shows the air dose rate average in each category (aggregated data of measuring points).
Residential areas include schools, parks, cemeteries, and large-sized facilities, farmland includes orchard, and forests include slopes, grassland and lawn.
Post-decontamination monitoring was implemented after 6 months to a year after the decontamination work. The latest result of post decontamination monitoring in municipalities were summarized

[Implementation period]	・Monitoring before decontamination	Nov.2011 - Nov. 2016
	・Monitoring after decontamination	Dec. 2011 - Dec. 2017
	・Post decontamination monitoring	Oct. 2014 - Aug. 2018

- Average air dose rate reduction: from 1.31 to 0.62 μSv/h right after remediation and to 0.44 μSv/h after several months
- Estimated remediation effectiveness: ~59% more reduction

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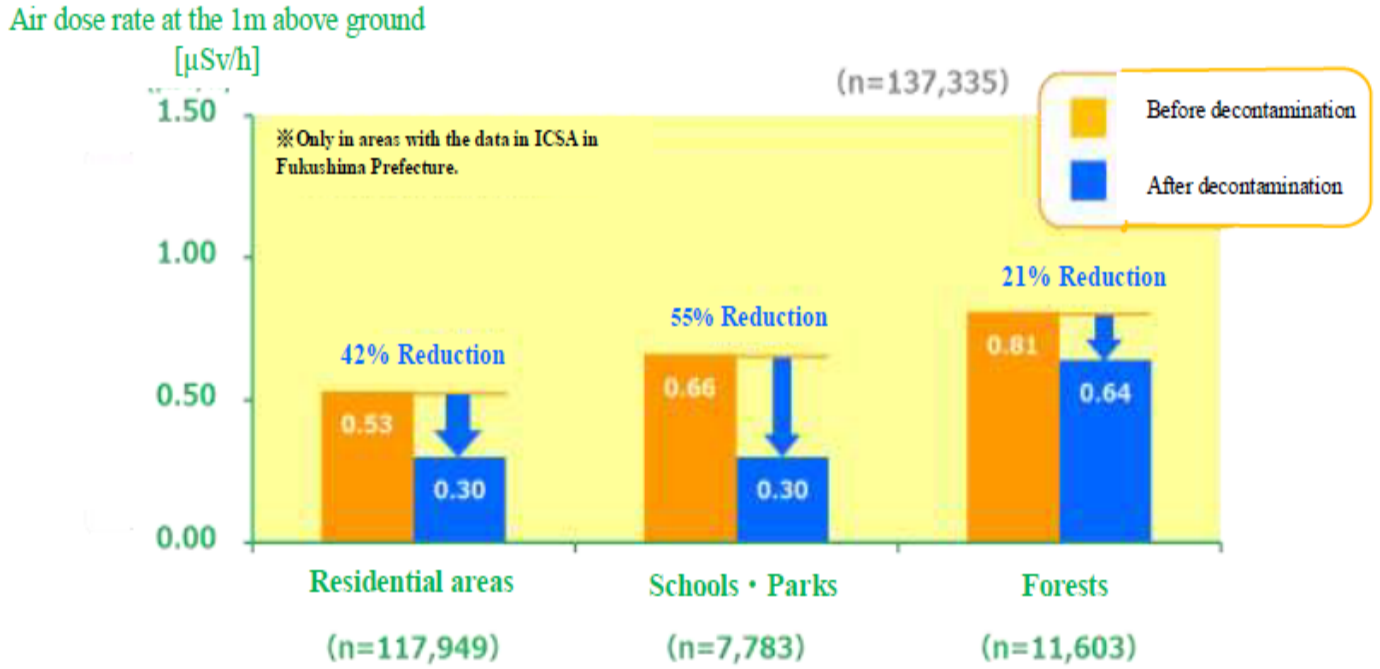
RESULTS OF WHOLE AREA REMEDIATION: ICSA (FUKUSHIMA)



Note) Averages of air dose rates of residential area, schools・parks, and forests (aggregation of measurement point data)
[Period of implementation]
[Residential areas] Before decontamination: July 2011 to Feb. 2016
After decontamination : July 2011 to Feb. 2016
[Schools and Parks] Before decontamination: June 2011 to Mar. 2015
After decontamination: June 2011 to Aug. 2015
[Forests] Before decontamination: Dec. 2011 to Dec. 2015
After decontamination: Dec. 2011 to Feb. 2016

- Average air dose rate reduction: from 0.53 to 0.30 μSv/h right after remediation
- Estimated remediation effectiveness: ~38% more reduction

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FOLLOW-UP REMEDIATION (SUPPLEMENTARY REMEDIATION)

- In SDA, supplementary remediation has been carried out at ~10,000 residences (Oct. 2017)
  - Water pathways such as slopes, rain puddles, roadside gutters, etc.
  - ~50% reduction of air dose rate
- Continuous monitoring
- Risk communication and health management with residents

VERIFICATION OF REMEDIATION

Verification committee on remediation in SDA

- Local governments
- Requirements to lift evacuation orders
- Dose reduction status and prospects
- Communication with stakeholders and experts
- Recommendations

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SUMMARY OF WHOLE AREA REMEDIATION PROJECT

◆The MOE has budgeted approx. JPY 2.9 trillion (= USD 27 billion) up to FY2017 for decontamination.
◆16,5mil.㎥ (among which approx. 16mil. ㎥ of the removed soil and wastes were estimated to have been removed until now *Estimation total number of SDA decontamination (as of January 2018) and ICSA decontamination (as of September 2017)
◆MOE is also working on "Decontamination Project Report" to leave a record behind of the experiences, knowledge and lessons learned through decontamination works.

Decontamination in SDA

- Total number of labor:
  approx. 13,600,000 workers
  ※as of the end of January 2018
- Budget: approx. JPY 1.5 trillion
  ※ MOE's budget until FY2017 (excluding unnecessary cost)
- Volume of the generated soil:
  approx. 9,000,000㎥

  From the above volume of soil already transported from TSS*: approx. 1,700,000㎥ (estimation as of the end of January 2018)

* Volume transported either to the ISF or to Temporary incineration facilities (TIFs)

Decontamination in ICSA

- Total number of labor:
  approx. over 18,000,000 workers
  ※ estimated from interviews with relevant municipalities
- Budget: approx. JPY 1.4 trillion
  (within Fukushima Pref. : approx. JPY 1.3 trillion,
  outside Fukushima Pref. : approx. JPY 5 billion
  ※MOE's budget until FY2017 (excluding unnecessary cost)
- Volume of the generated soil:
  approx. 7,500,000㎥ (estimation)
  (within Fukushima 7,000,000㎥,
  outside Fukushima 500,000㎥, both are estimation)

  From the above volume of soil already transported from TSS*: approx. 1,300,000㎥ (as of the end of January 2017)

※Considered 1US$ =JPY107

SUMMARY OF WHOLE AREA REMEDIATION PROJECT CONT'D

Impact of remediation project to the communities:

- Reduction of the residents' anxiety (Murakami et al. doi:10.1620/tjem.241.103)
- Potential improvements in the effectiveness and acceptability of long-term radiation risk management (Murakami et al. doi:10.1620/tjem.241.103 and Oughton, D. 651-653. doi:10.1002/ieam.1831)
- Positive impact to the local economy from high resource demands (supplies, lodging, equipment, etc.) and increased hiring opportunities
- Struggling with waste stored in local communities
- Expectation of remediation has changed as the remediation progresses.

LESSONS LEARNED FROM FUKUSHIMA REMEDIATION

1. Holistic Preparation of Remediation
   Cleanup activities are connected

2. Coordination
   Coordination of all relevant parties is the key for effective remediation and community recovery

3. Selection of Remediation Methods
   No single method that can work for all surfaces and media

LESSONS LEARNED FROM FUKUSHIMA REMEDIATION CONT'D

4. Roles of Experts
   - Deliver objective opinions; Help the decision makers for remediation; Help the government officials for stakeholder communication

5. Stakeholder Engagement for Remediation
   - Clear and transparent communication with stakeholders to improve the public trust and as a result effective decision can be made during remediation

6. Remediation Workers and Work Environment
   - Large scale remediation needs significant number of workers for years
   - Coordination with local communities is the key to resolve the most of challenges

7. Hotspot Identification
   - Hotspot removal is the most effective approach to reduce the radiation level with minimal efforts

LESSONS LEARNED FROM FUKUSHIMA REMEDIATION CONT'D

8. Importance of Availability of Critical Infrastructures
   - Critical infrastructure remediation as high priority

9. Impact of environmental conditions on remediation implementation
   - Application and effectiveness of remediation methods are greatly impacted by the weather conditions

10. Remediation of natural area
   - Difficult to remediate natural area effectively and needs continuous assessment

https://jopss.jaea.go.jp/pdfdata/JAEA-Review-2014-052.pdf

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MESSAGES FOR RESPONDERS AND DECISION MAKERS

- Radiation Experts
- Remediation Technologies
- Labor and Equipment
- Holistic Preparation
- Remediation Exercises

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