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Radiation Monitoring and Remediation after Fukushima Daiichi NPP accident - The IAEA's assistance and support to the Fukushima Prefecture –

IAEA

Radiation Safety and Monitoring Section

Miroslav Pinak

Odborný seminář: “Realizace následných ochranných opatření na území po radiační havárii” (Ministerstvo zemědělství, Státní úřad pro jadernou bezpečnost a Státní ústav radiační ochrany)

- **Assistance of the IAEA to the Fukushima Prefecture after the TEPCO Dai-ichi NPP Accident**
as the Specific Activity under the
- The IAEA's role in the system of radiation protection and Safety Standards - way to harmonize radiation protection approaches
and
- The IAEA programmes in radiation safety

What is the IAEA's role in Radiation Safety



to **(1) establish or adopt**, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards for safety for protection of health and minimize of danger to life and property, and to **(2) provide for the application of these standards**...., at the request of the parties, ... or at the request of a State...

from Statute of the IAEA, Article III.A.6

Main goal:

Improved radiation safety in Member States through the establishment and global acceptance of the IAEA safety standards

through:

ensuring that the fundamental **basis for radiation safety is in place**, paying particular attention to the **protection of members of the public, patients and workers**

Key publications to be used in the case of assistance programmes to the Prefecture:

IAEA Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (BSS) and Associated safety guides and technical documentation

While radiation protection and safety is a **national responsibility**, **international standards** and approaches:

- promote **consistency**;
- help to **provide assurance** that nuclear and radiation related technologies are used safely; and
- facilitate **international cooperation and trade**.


Practical Application of IAEA Safety Guides



IAEA Safety Standards
for protecting people and the environment

Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards

Jointly sponsored by
EC, FAO, IAEA, ILO, OECD/NEA, PAHO, UNEP, WHO




General Safety Requirements Part 3
No. GSR Part 3




IAEA Safety Standards
for protecting people and the environment

Radiation Protection of the Public and the Environment

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General Safety Guide
No. GSG-8




IAEA Safety Standards
for protecting people and the environment

Prospective Radiological Environmental Impact Assessment for Facilities and Activities

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General Safety Guide
No. GSG-10




IAEA Safety Standards
for protecting people and the environment

Regulatory Control of Radioactive Discharges to the Environment

Jointly sponsored by
IAEA UN/WHO



General Safety Guide
No. GSG-9



IAEA Safety Standards
for protecting people and the environment

Arrangements for the Termination of a Nuclear or Radiological Emergency

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General Safety Guide
No. GSG-11



- **Requirement 46:** Arrangements for the transition from an emergency exposure situation to an existing exposure situation. The **government shall ensure that arrangements are in place** and are implemented as appropriate for the transition from an emergency exposure situation to an existing exposure situation
- **4.21.** Workers undertaking work such as undertaking remedial actions for the decontamination of the site and surrounding areas, shall be subject to the relevant requirements **for occupational exposure in planned exposure situations stated in Section 3 (of the GSR Part 3)**
- **5.1.** The requirements for **existing exposure situations** in Section 5 apply to
 - (a) Exposure due to **contamination of areas** by residual radioactive material deriving from....
 - (ii) A nuclear or radiological emergency**, after an emergency has been declared to be ended



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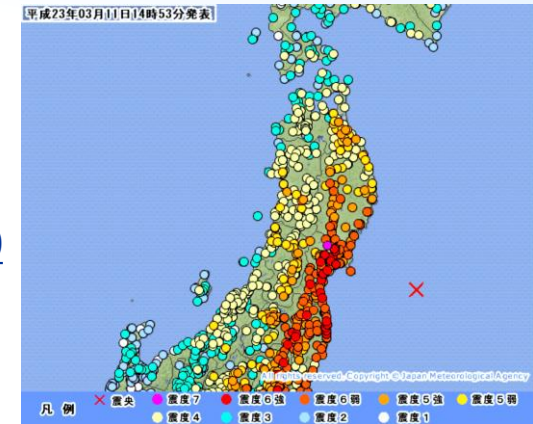
TEPCO Dai-ichi NPP Accident

The earthquake happened

- **Date of occurrence:** 14:46 on Friday, March 11, 2011
- **Epicenter:** Offshore Sanriku (38°N, 142.9°E), Depth of hypocenter: 24 km
- **Magnitude: 9.0** -The largest in recorded history (130 years) in Japan.
The U.S. Geological Survey Office placed the quake as the 4th largest in the world since 1900

- **Seismic intensity:**

- 7: Kurihara city, Miyagi prefecture
- **Upper 6:** Hitachi city, Ibaraki prefecture, Naraha-cho, Tomioka-cho, Okuma-machi, Futaba-cho, **Fukushima prefecture**, Natori city, Miyagi prefecture, etc.
- Lower 6: Ofunato city, Ishinomaki city, Onagawa-cho, Miyagi prefecture, Tokai village, Ibaraki prefecture, etc.
- Upper 5: Miyako city, Iwate prefecture, Fukushima city, Fukushima prefecture, Taihaku ward, Sendai city, Miyagi prefecture
- Lower 5: Kuji city, Iwate prefecture, Kariwa village, Niigata prefecture
- 4: Rokkasho village and Higashidori village, Aomori prefecture, Kashiwazaki city, Niigata prefecture, Tadamicho, Fukushima prefecture

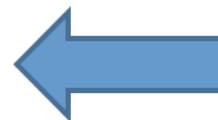


... and then the tsunami reached the shore



max (estimated)
tsunami height
is **39 m** at Aneyoshi,
Miyako city)

Minami Sanriku:
city literally “swept-out from
the surface of the earth”
(photos taken in August
2011)



... and then the tsunami hit the TEPCO Dai-ichi NPP

the TEPCO Dai-ichi NPP was protected by a 5.7 m tsunami barrier but the wave height apparently exceeded 10 m (max estimated 14 m at the NPP site) causing :

- flooding the diesel generators; and
- flooding electrical wiring in the basement and lower levels of the power plant.

Station Black Out with:

- loss of ALL instrumentation control
- loss of control of reactors 1-4
- loss of communication means
- loss of emergency electricity supply (only one diesel generator functioning at reactor 6)
- loss of external power grid
- loss of light, ...



unprecedented widespread destruction and catastrophic conditions of enormous scale (six reactors, six nuclear fuel pools with no instrumentation control)

TEPCO Dai-ichi NPP Accident, 11 March 2011 – 10 years on



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A Decade of Progress in Safety Since the Fukushima Daiichi Accident Highlighted at the Annual Forum of the International Nuclear Safety Group

Eni Lamce, IAEA Department of Nuclear Safety and Security

SEP
20
2021



The IAEA team headed by Lydie Evrard, IAEA Deputy Director General and Head of the Department of Nuclear Safety and Security (centre), and also including Gustavo Caruso (left), Coordinating Director for the IAEA ALPS treated water project, met with experts at the Fukushima Daiichi site and observed key activities and locations of interest for the IAEA review. (Photo: TEPCO)

Progress in decommissioning of the Fukushima Daiichi Nuclear Power Plant, improved assessment of external hazards such as earthquakes, regulatory and safety upgrades implemented at nuclear power plants globally as well as the safety of advanced and innovative reactors were among topics discussed at the annual International Nuclear Safety Group (INSAG), held today on the side-lines of the 65th IAEA General Conference.

Related stories

IAEA Assistance has Contributed to Safer Environment in Fukushima Prefecture, Local Officials Said

Nuclear Power 10 Years After Fukushima: The Long Road Back

Resilience of Nuclear Power During COVID-19 Pandemic Highlighted at the Annual Forum of the International Nuclear Safety Group

INSAG Forum Discusses Safety-Security Interface Developments and Challenges

Register for the IAEA Conference to Further Strengthen Nuclear Safety

Related resources

65th IAEA General Conference, 20-24 September 2021

International Nuclear Safety Group (INSAG)

- Technical expertise
- Equipment
- Expert missions (4 per year approx.)
- Guidance on recovery operations

“Since 2012, the IAEA has been providing assistance to the Prefecture ... including radiation monitoring, and analyzing and communicating the results effectively. Children are now playing in school playgrounds and hikers are using the forests of Fukushima Prefecture where access was restricted following the accident, and we see this as a definite success.”

[A Decade of Progress in Safety Since the Fukushima Daiichi Accident Highlighted at the Annual Forum of the International Nuclear Safety Group | IAEA](#)



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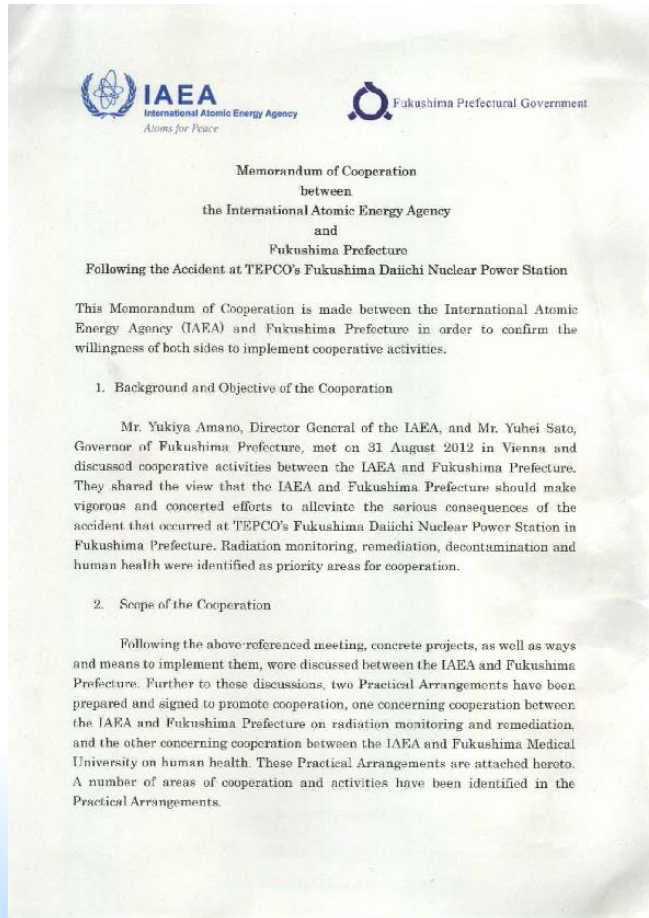
Assistance of the IAEA to the Fukushima Prefecture

IAEA Assistance in Response to Radiological Accident in the Fukushima Prefecture – initial discussions

- Remediation
- Monitoring
- Land Use
- Decommissioning and Management of Radioactive Waste
- Management of Radiation Phobia and Post-Traumatic Stress
- Public Information



Origin and scope of the cooperation



Following the accident at TEPCO's Fukushima Daiichi nuclear power plant, the IAEA and the Fukushima Prefecture agreed to cooperate on radiation monitoring and remediation. The Practical Arrangements on this cooperation aim to provide broad and extensive assistance in the Prefecture in these two areas, complementing existing Japanese activities and providing immediate assistance and support that directly benefit those living in the Prefecture.

Radiation monitoring & mapping

- including the application of environmental mapping technology by using unmanned aerial vehicles, and using radiation monitoring data to develop maps to be made available to the public

Remediation & decontamination

- Off-site decontamination, including in analyses of environmental monitoring results and the exploration of exposure pathways so as to reduce or avoid exposure

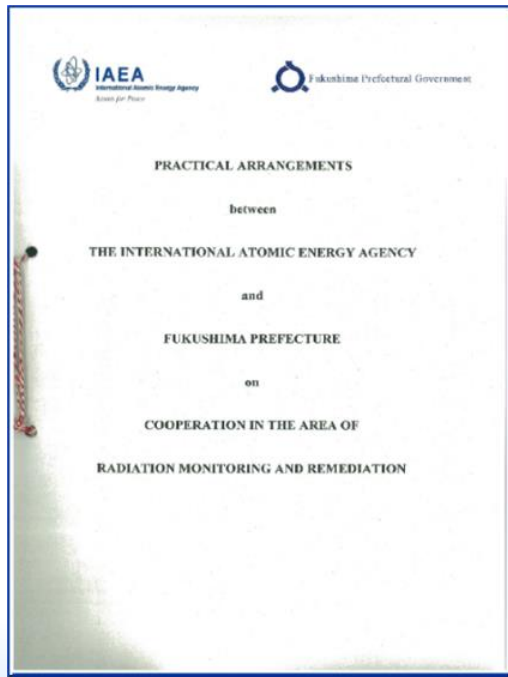
Management of radioactive waste

- The management of radioactive waste and on management methods of low-level radioactive waste from off-site decontamination activities

Formal Agreements on collaboration between the IAEA and the Fukushima Prefecture

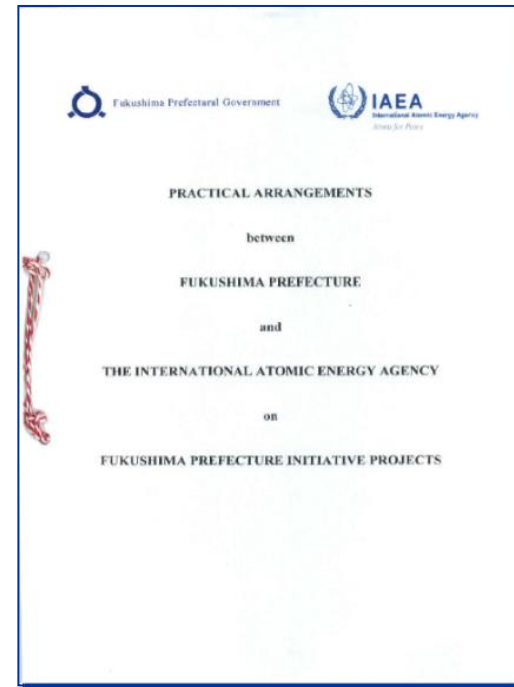


Fukushima Cooperative Projects



Activities are conducted by Fukushima Prefecture and include monitoring of air dose rates of radiocaesium, protection of forest workers against radiation, safe management of radioactive waste from remediation activities and effective communication of these results to the general population.

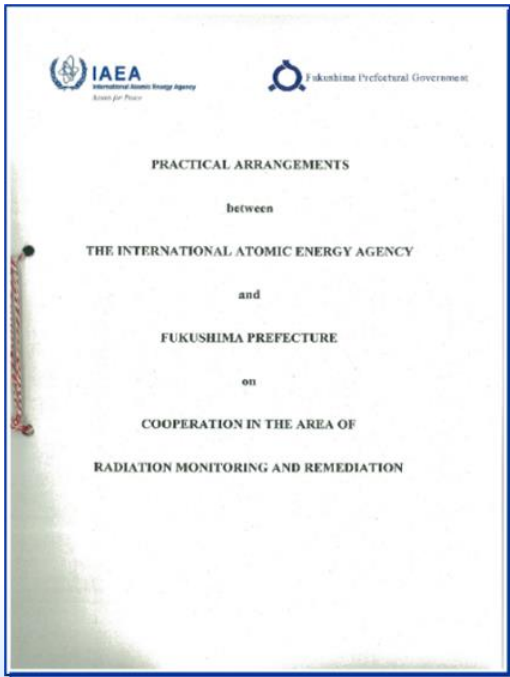
Fukushima Initiative Projects



Projects are supported by the IAEA and include monitoring of the movement of radionuclides in river waters and among wildlife such as wild boar, in order to foster a sense of safety and security and in light of lifting shipping restrictions, and the development of environmental mapping using Global Positioning System (GPS) data for quick and precise radioactivity measurements, particularly across terrain that is inaccessible on foot.

Formal Agreements on collaboration between the IAEA and Fukushima Prefecture

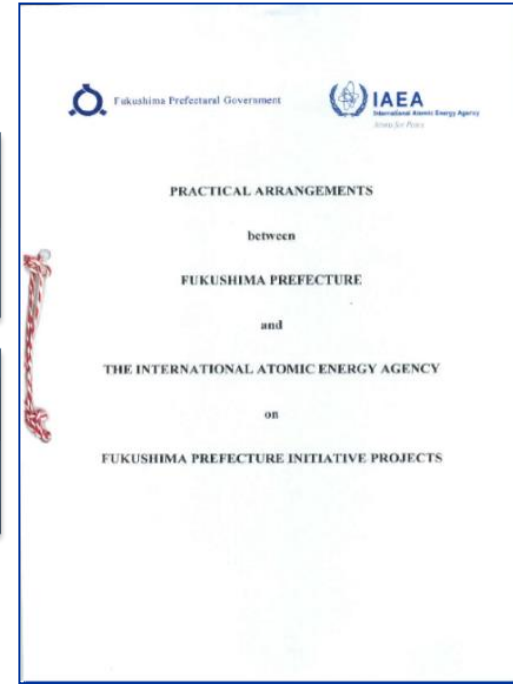
Fukushima Cooperative Projects



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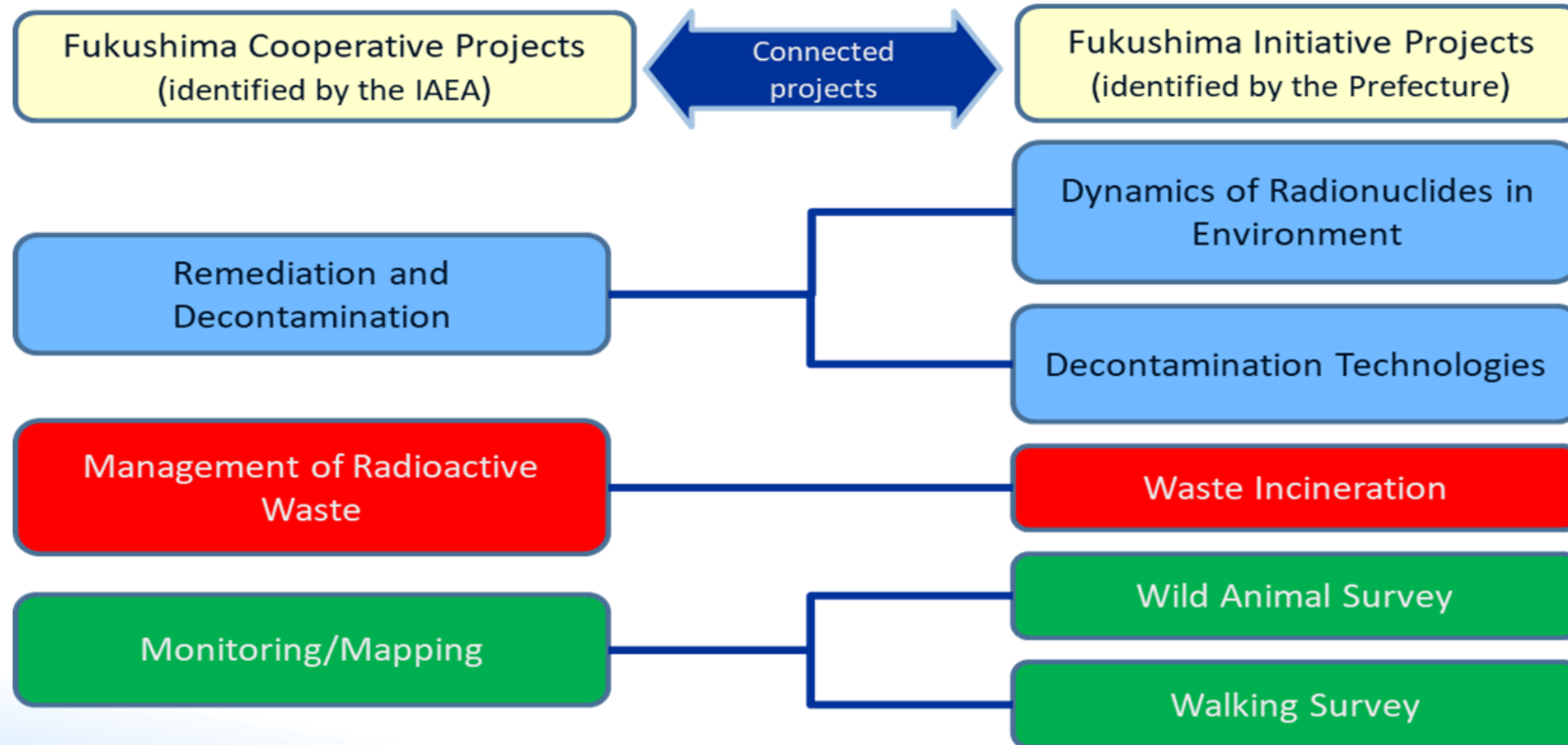
Fukushima Initiative Projects



Projects are supported by the IAEA

- monitoring of the movement of radionuclides in river waters
- monitoring of the movement of radionuclides among wildlife such as wild boar

IAEA assistance to the Fukushima Prefecture on radiation monitoring, remediation and decontamination in off-site areas



Examples of several projects aiming to assist the Fukushima Prefecture



General Projects

Remediation and Decontamination

Radioactive Waste from Remediation Activities

Radiation **Maps for Public**

Radiation Protection of **Workers in Emergency Situation**

International Expert Meeting on Radiation protection after TEPCO

Dai-ichi NPP Accident

Safety criteria for **Food and Drinking Water**

Specific Projects

Environmental Mapping

Radionuclide Movement in **Rivers and Lakes**

Radionuclide Movement with **Wildlife**

Decontamination Technology for Rivers and Lakes

Disposal at Municipal **Waste Incinerator**

Individual Projects:

Development of the Methodology for **Remediation** and **Decontamination**

Assistance in Management of **Radioactive Waste** from Remediation Activities

Development of **Radiation Maps for Public**

Development of Radiation Protection of **Workers in High Exposure Situations**

Clarification of International **Criteria for Food and Drinking Water**

Assistance in **Research of Radionuclide Movement in Rivers and Lakes Wildlife**

Development of **Decontamination** Technology for Rivers and Lakes

Assistance in Research of Disposal of Radioactive Waste at Municipal **Waste Incinerator**

Remediation and Decontamination in the Fukushima Prefecture

- **Objectives**

- To provide assistance on remediation activities and re-settlement of evacuees

- To support activities that maintain, develop or restore public confidence;

- **Topics**

- **Behavior of cesium in the environment**

- Soil, rivers and lakes

- Urban areas Parking lots, streets, parks

- **Time trends & implications for resettlement**

- Loss of cesium from these environmental media

- Reduction of the gamma-dose rate

- **Remediation and decontamination techniques**

- Past experience

- Feasibility, costs, side-effects, etc.

- **Counterparts**

- Fukushima Prefectural Government

- Municipalities of the Prefecture

- Specific groups: teachers, hunters, fishermen



Management of Radioactive Waste from Remediation Activities

- **Objectives**

- To assist and provide advice in safely managing large amounts of radioactive waste (all steps)

- To provide advice on the management of waste at municipal incinerators

- To support activities that maintain, develop or restore public confidence;

- **Topics**

- **Management of large amounts of waste from remediation activities**

- Issue of shortage of sites for temporary storage (siting, design, radiological impact...)

- **Management of waste at municipal incinerators**

- Optimization of the temperature of incineration

- Management of remaining waste (filters, bottom ash...)



- **Counterparts**

- Fukushima prefectural government

- Municipalities of the prefecture

- Public as appropriate

Assistance in the Use of Radiation Monitoring Data to Develop Maps to be Made Available to the Public



- **Objectives**

- To map radiation data in a manner that is helpful for decision-making and public information

- **Topics**

- Compatibility of different data sets (aerial monitoring, dose rate measurements, in-situ spectrometry, walking surveys etc.)

- How to map the forest ecosystem (70% of Fukushima Prefecture)

- How to regularly update maps as circumstances change

- How to use the maps as an effective communications tool

- **Counterparts**

- Department of Agriculture, Forestry and Fisheries

- Fukushima Environmental Radiation Monitoring Centre

- Fukushima Social Affairs and Environmental Department



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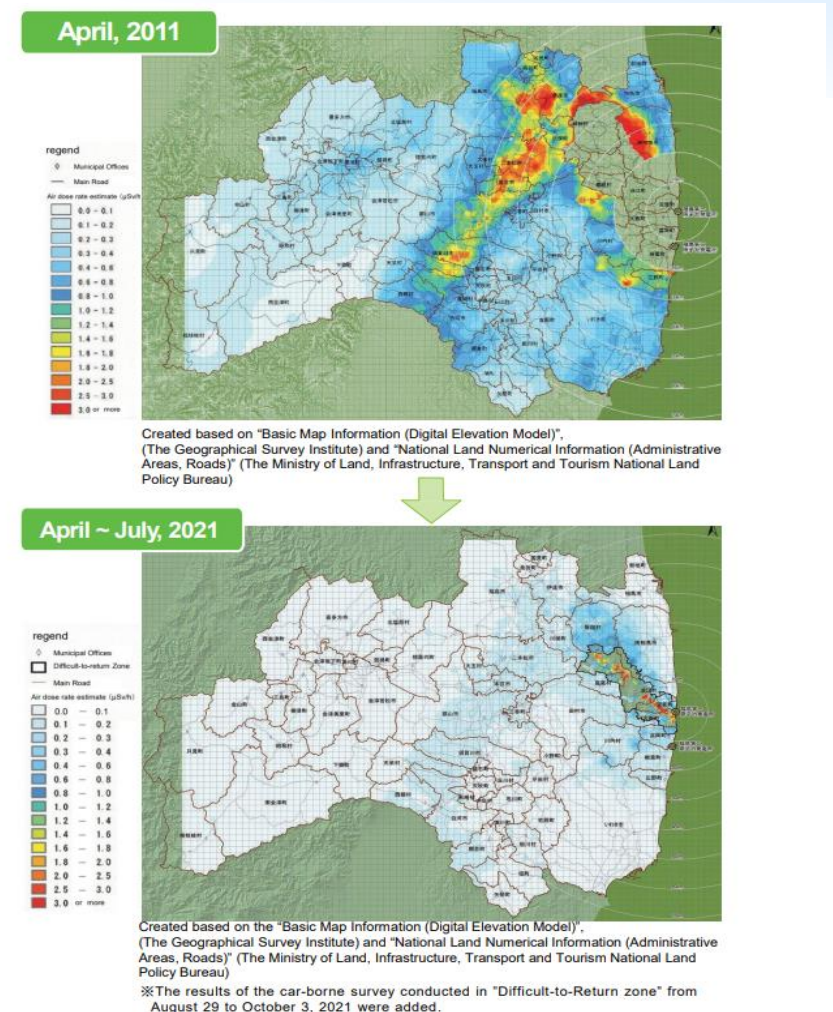
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Examples of selected results

Changes in air radiation dose rate in the Fukushima Prefecture

The air radiation dose rate in Fukushima Prefecture has decreased significantly from that as of April 2011.

In the Nakadori and Hamadori regions, the effects of natural attenuation and decontamination of radioactive substances are definitely appearing. The Aizu region has been restored to the air radiation dose level which existed before the nuclear accident.



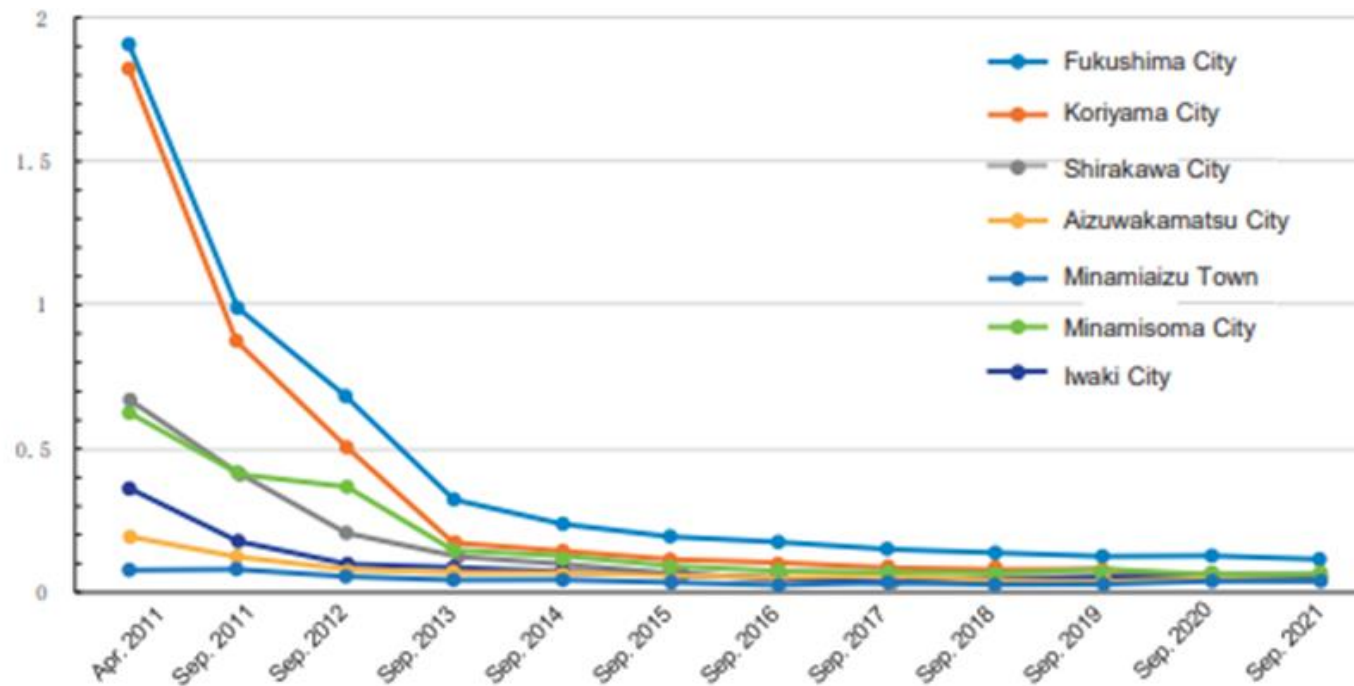
Selected results (monitoring)

Air dose rate in Fukushima Prefecture

Measurement date ※1	Measurement point ※2	Fukushima City	Koriyama City	Shirakawa City	Aizu-wakamatsu City	Minamiaizu Town	Minamisoma City	Iwaki City
Before the accident (2009) ※3		0.04	0.04	0.04	0.05	0.04	0.05	0.06
April 2011		1.91	1.83	0.67	0.19	0.08	0.63	0.37
September 2011		1.00	0.88	0.42	0.13	0.08	0.42	0.18
September 2012		0.69	0.51	0.21	0.09	0.06	0.37	0.10
September 2013		※4 0.33	※4 0.17	0.12	0.07	0.05	0.15	0.09
September 2014		0.24	0.14	0.10	0.07	0.05	0.12	0.08
September 2015		0.20	0.12	0.09	0.06	0.04	0.09	0.07
September 2016		0.18	0.10	※4 0.08	0.06	0.04	0.08	0.07
September 2017		0.15	0.09	0.07	0.05	0.04	※4 0.08	0.06
September 2018		0.14	0.09	0.07	0.05	0.04	0.07	0.06
September 2019		0.13	0.08	0.06	0.05	0.04	0.07	0.06
September 2020		0.13	0.07	0.06	0.05	0.04	0.06	0.06
September 2021		0.12	0.07	0.06	0.05	0.04	0.06	0.06

Source link: https://www.iaea.org/sites/default/files/22/06/fuku-moni_march_2022revised_.pdf

Air radiation dose rate in the Fukushima Prefecture



Source link: https://www.iaea.org/sites/default/files/22/06/fuku-moni_march_2022revised_.pdf

Examples of information dissemination



Examples of information dissemination



Summary Workshop on IAEA assistance to Fukushima Prefecture in Miharuru, January 2023 (attended by SURO representatives)





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Instead of conclusions

The IAEA Standards have been developed over decades based on scientific research and **USED in a very particular case in addressing a real need**. This has been in many cases, an unprecedented situation.

Through applying of the IAEA Standards, when moving from theory to practice, issues like **optimization of remediation actions, safety radioactive waste fields, monitoring and explanation of monitoring data** have been addressed.

When undertaken the assistance, it has been recognized that some **radiation protection challenges remain** and the IAEA, together with the Prefecture has been addressing them by seeking and supporting **possible solutions**.