IAEA
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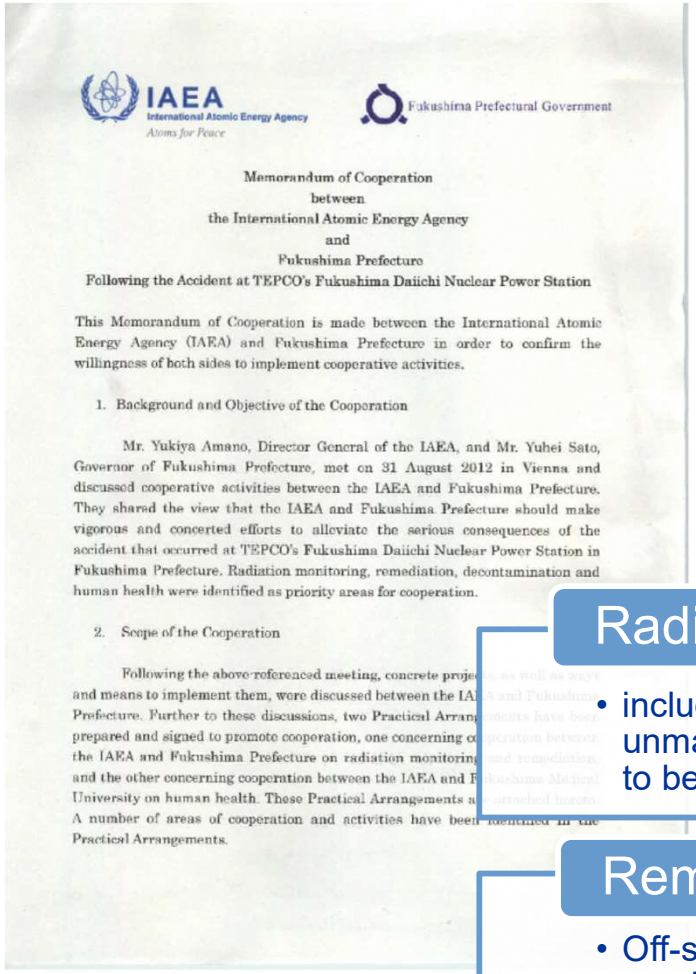
Radiation Monitoring and Remediation after Fukushima Daiichi NPP accident

- The IAEA's assistance and support to the Fukushima Prefecture -

Summary of the discussions

Miroslav PINAK
Technical Leader
of the IAEA-Fukushima Prefecture Cooperative Project
IAEA

Origin and scope of cooperation



IAEA International Atomic Energy Agency
Atoms for Peace

Fukushima Prefectural Government

Memorandum of Cooperation
between
the International Atomic Energy Agency
and
Fukushima Prefecture
Following the Accident at TEPCO's Fukushima Daiichi Nuclear Power Station

This Memorandum of Cooperation is made between the International Atomic Energy Agency (IAEA) and Fukushima Prefecture in order to confirm the willingness of both sides to implement cooperative activities.

1. Background and Objective of the Cooperation

Mr. Yukiya Amano, Director General of the IAEA, and Mr. Yuhei Sato, Governor of Fukushima Prefecture, met on 31 August 2012 in Vienna and discussed cooperative activities between the IAEA and Fukushima Prefecture. They shared the view that the IAEA and Fukushima Prefecture should make vigorous and concerted efforts to alleviate the serious consequences of the accident that occurred at TEPCO's Fukushima Daiichi Nuclear Power Station in Fukushima Prefecture. Radiation monitoring, remediation, decontamination and human health were identified as priority areas for cooperation.

2. Scope of the Cooperation

Following the above-referenced meeting, concrete proje... as well as ways and means to implement them, were discussed between the IA... and Fukushima Prefecture. Further to these discussions, two Practical Arran... have been prepared and signed to promote cooperation, one concerning c... between the IAEA and Fukushima Prefecture on radiation monitoring ... remediation, and the other concerning cooperation between the IAEA and F... Medical University on human health. These Practical Arrangements a... attached hereto. A number of areas of cooperation and activities have been identified in the Practical Arrangements.

Following the accident at TEPCO's Fukushima Daiichi nuclear power plant, the IAEA and the 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

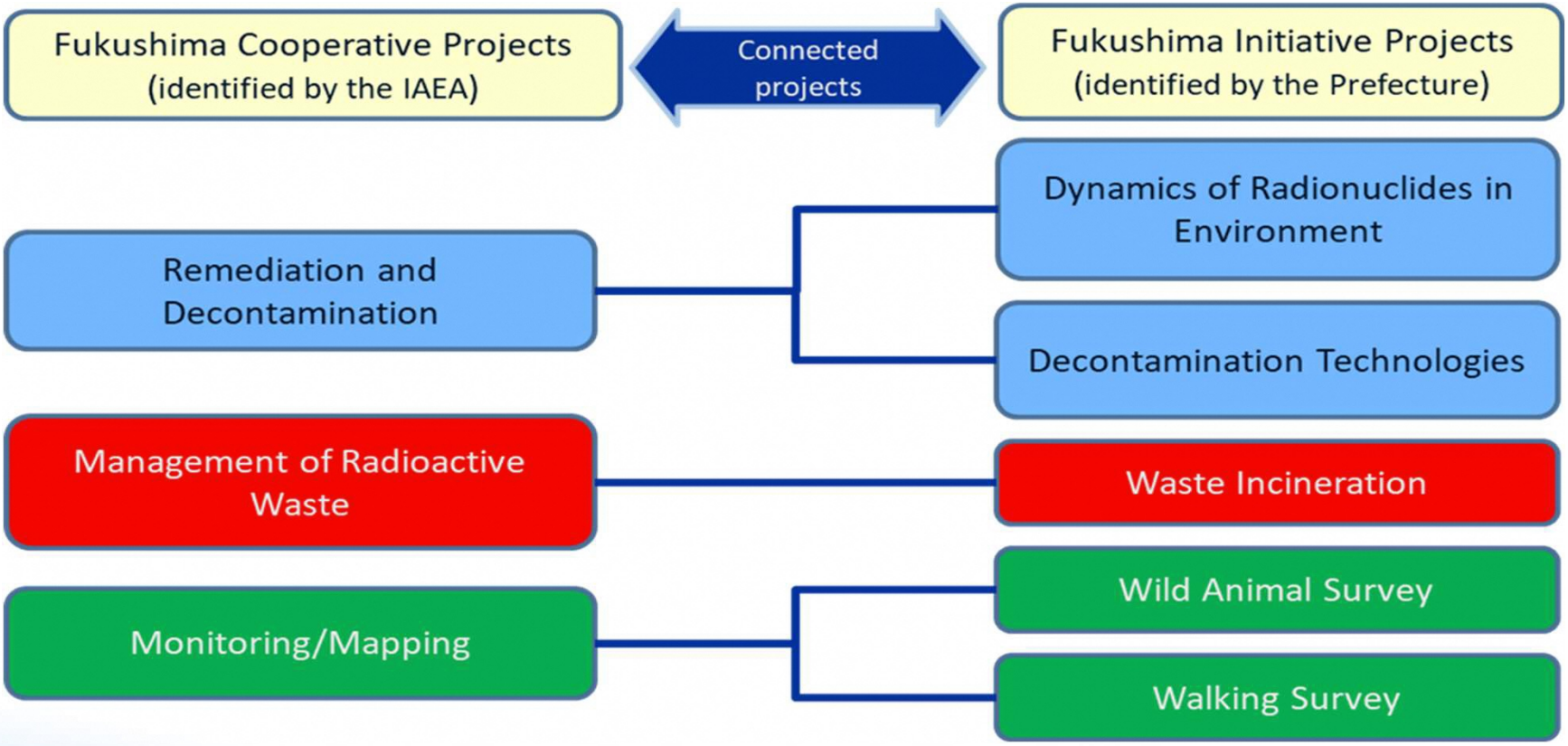
Remediation & decontamination

- 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

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

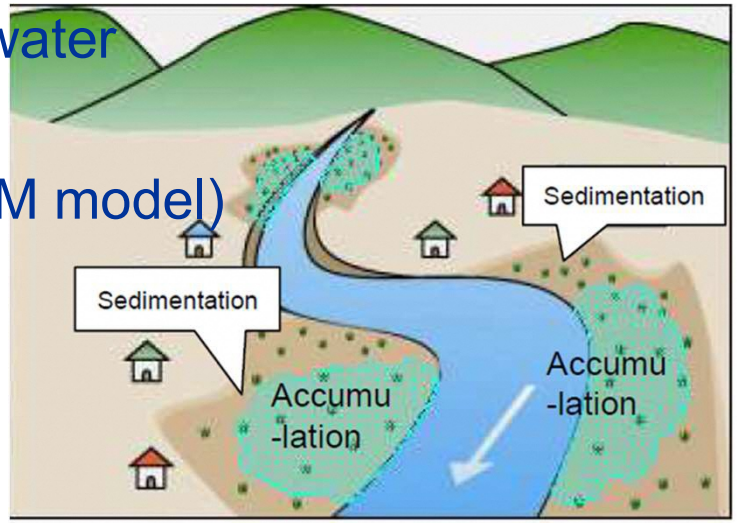


* Subject covered in the beginning of assistance

Remediation & Decontamination Session

Topics covered by FCP1, FIP1 and FIP3

- Radiocaesium (Cs-137 and Cs-134) in freshwater systems
  - Suspended and dissolved radiocaesium in water
  - Source of radiocaesium in sediments
  - Time-dependence of radiocaesium in river water
  - Loss of radiocaesium from catchments
  - Simulation of radiocaesium in rivers (TODAM model)
  - Radiocaesium microparticles
- Decontamination work in rivers
- Options for countermeasures in freshwaters
- Decontamination work in the terrestrial environment
- Dissemination of results

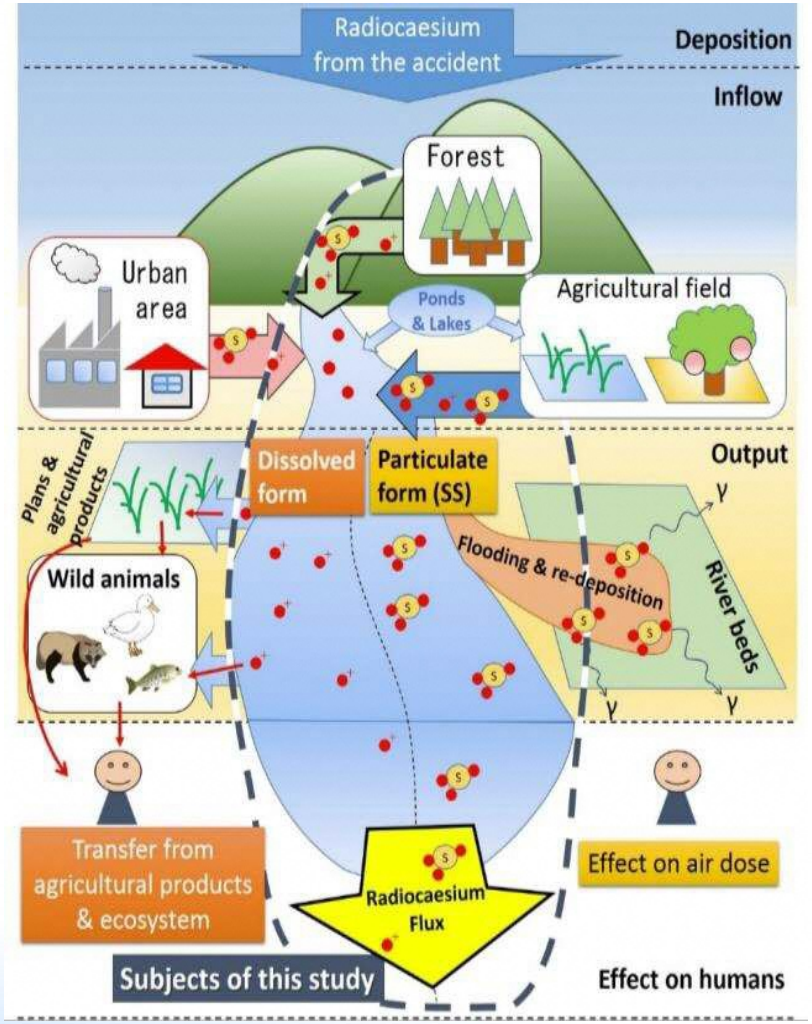


(Reference: the website of Ministry of Land, Infrastructure, Transport and Tourism)

Key findings: Behaviour of radiocaesium in aquatic systems

- Environmental and climatic conditions in the Fukushima and Chornobyl regions are quite different but the behaviour of radiocaesium in the environment is similar.
  - Strong sorption of caesium to solids.
  - In fresh waters, most of the Cs-137 is found in suspended or bottom sediments
- Survey data indicate a continuous decline in radiocaesium concentrations in rivers since 2011. Decline observed in the Prefecture and in other parts of the world agree reasonably well.
- Predictions using a simulation model for dynamics in rivers (TODAM) show agreement with measurements under base- and high-river flow conditions.

Key findings: Behaviour of radiocaesium in aquatic systems



- In the Prefecture, loss of Cs-137 due to run-off depends on the land-use. The loss is low – about 1% in the year of deposition and well below 1% per year thereafter.
  - General agreement with experience in other countries
- Environmental tracers, such as ∂13C, can serve as powerful tools to trace Cs-137 in the environment.
- Small number of CsMPs have been found - low levels of radiocaesium bound to them. Cs-137 bioavailability is likely to be low and no significant impacts are likely.

Key findings: remediation of terrestrial environment

- Countermeasures that control release of Cs-137 into surface waters (e.g. decontamination of upstream environments) can be an effective approach to prevent accumulation in sediments in aquatic systems

- Gamma dose rates in forests, on agricultural lands and residential areas after decontamination are reduced by about 30-50 %, both in Chornobyl and Fukushima

- For reducing Cs-137-levels in crops, a similar range of techniques was applied after the Chornobyl and Fukushima accidents. Where comparable, reduction factors are similar

Key findings: Control of dispersion in dynamic aquatic systems: engineering measures

- Aquatic systems are complex and very site specific
- Large-scale engineering measures are costly and often difficult to implement.
- Natural sediment traps worked well e.g., at the Yokokawa dam and at the Kiev reservoir in Ukraine.
  - Calm waters with low water flows leading to high sedimentation
- Removal of bottom sediments is an effective and globally applied measure for remediation of water bodies (including demonstration test in the Prefecture).
- Removal of riverside sediments and vegetation (demonstration test in Kami-Oguni river) reduced dose rates by a factor of about 2: this reduction persisted and was not affected by typhoons and flooding.

Discussion topics: future questions

- Human activities, land use, the existence of dams and decontamination activities within a river basin influence the transfer of radiocaesium through river systems

  - Future monitoring will show the impact of future changes and clarify the long-term dynamics in the aquatic environment
  - Stable C tracers could continue to be used to help predict fluxes of sediments and influence of local conditions

- Interest in using the TODAM simulation model for predicting future trends of radiocaesium in rivers – could be useful for exploring impact of high water flow rates and impact of climate change.

- It was suggested that further work on evaluating the cost-effectiveness of countermeasures compared to natural attenuation could be used to inform future work e.g. ,decontamination of riverbanks

Waste Management Session

Topics Covered by FCP2 & FIP5

- FCP2: **Management of Waste from Remediation Activities**
  - Technical Guidelines for TSS
  - Safety Assessment for TSS
- FIP5: **Study of Proper Treatment of Waste containing Radioactive Material**
  - Treatment of Waste Containing Radioactive Material
  - Municipal Waste Landfills in Japan
  - Safety Assessment for Municipal Landfills
  - Dose Modelling Aspects

Key Findings (FCP2 & FIP5)

- After the 2011 Fukushima Daiichi accident, enormous amounts of materials were managed as radioactive waste

- A cumulative total of over 1000 Temporary Storage Sites (TSS) were established in the Prefecture based on “Technical Guidelines”.

- The waste was later moved to Interim Storage Facilities

- The IAEA assisted the Prefecture by:
  - Explaining IAEA Safety Standards
  - Reviewing the Technical Guidelines
  - Sharing expertise and experiences from outside Japan
  - Training the Prefecture on assessing the safety of TSS
  - Reviewing and advising on Prefecture’s research on Cs in incineration ashes
  - Training the Prefecture to assessing the safety of Cs-containing ash in landfills
  - Advising on the presentation and communication of information

Key Points (FCP2)

- The Prefecture's capabilities on radioactive waste management were significantly enhanced

- The Technical Guidelines worked as procedures for safe waste management, comments were provided to the Prefecture on all the versions of the Technical Guidelines (version 6 is the actual version)
- Support was provided by the IAEA to the Prefecture for the safety assessment of Temporary Storage Sites for normal and accidental situations and for all phases of development
- Assessed doses during operation of TSS and after waste removal are well below relevant dose limits and long-term goals

Key Points (FIP5)

- The incineration of contaminated materials (e.g. Waste from outdoor sources) produced Cs-contaminated incineration ashes
- The safety of landfilling ashes, containing up to 8000 Bq/kg of Cs, at one site was assessed using IAEA's "Clearance Tool" software, specifically adapted to conditions in Japan
- For the amount of radioactive Cs in ash disposed of, the calculated additional doses to residents living near the landfill in the future are very low
- Even if people live on the landfill in the future and drink water from the site, the doses are estimated to be below 1 mSv/year
- To guarantee representativeness of the results in the Prefecture, further work would be needed to assess other landfill sites

Discussion Topics

- Strategic Environmental Assessment (SEA)
  - Could SEA as applied to landfills in Japan be applied elsewhere in the world? SEAs are done quite widely for landfills (e.g. in the U.K.), so in principle, yes, the approach used in Japan is used elsewhere. If radioactive waste is to be disposed, the safety case is required as well as is SEA.

- Landfilling of radioactively contaminated waste
  - What stakeholder management was done? Positions of stakeholders to waste disposal need to be assisted by scientists who have understanding of public perception.

- Public acceptance
  - The FCP2 and FIP5 projects addressed the safety of temporary storage and of landfill disposal, but was there a change in public perception following these activities of demonstrating the safety of those facilities? Briefings on the TSS were given to the public and the municipalities on the safety of the facilities.

Discussion Topics

- ‘On-site’ waste storage
  - There were some 190,000 ‘on-site’ storage sites (storage in decontamination sites) where waste was kept before transport to TSS. Sometimes on-site storage lasted for several years (e.g. residential gardens). Was this covered in the IAEA – Prefecture discussions? The number of on-site storage sites has reduced (to～770) due to the removal of waste to interim storage facilities, but there are indeed some that remain. The Technical Guidelines cover on-site storage and were reviewed by the IAEA, but the main focus of the collaboration was on TSS.

- Incineration
  - How efficient is the incineration and what is the effect of combustion temperature on the distribution of Cs in ashes? Tests with radionuclides are not being done at the actual incinerator facility, but instead simulations are being done.

Monitoring Session

Topics

FCP3	FIP2	FIP4
• Forest • Mushroom • Fish	• Survey of radionuclide movement with wild animal	• Walking surveys • Environmental mapping
2013 - 2022	2013 - 2022	2013 - 2016

Findings: radiocaesium in forests (FCP3 <forest, mushroom>)

- Radionuclides deposited in the forests of the Prefecture are effectively retained within the forest ecosystem and the likelihood of transfers of radiocaesium to agricultural land appears to be low
- Forest maintenance procedures are very effective at retaining radiocaesium within forests
- The presence of clay minerals in the underlying forest soils has chemically bind the radiocaesium and limit its transfer to vegetation
- Measures have been implemented to restrict the radiation exposure of forest workers

Findings: Monitoring in forests (FCP3 <forest, mushroom>)

- Radiation monitoring in forest may be necessary for many more years
- Optimization of forest monitoring is needed moving forward due to available resources
- How long will monitoring of forests and forest products be needed?

Findings: monitoring of wild foods (FIP2, FCP3)

- Activity concentrations in wild foods are variable but there are high concentrations still being measured in 2022 that are >100 Bq/kg.
- Decline in Cs concentrations in wild mushrooms and other wild foods is slow and restrictions may be required for many years for some species and in some areas
  - so monitoring will need to continue in the long-term to provide surveillance and reassurance and to remail vigilant to changes in forest systems
- Non-destructive analysis method has been tested for matsutake mushrooms to avoid destroying expensive mushroom species
- Although significant progress has been made over the past decade in lifting distribution restriction for inland fish, there are still restrictions on some fish species in some areas, and recreational fishing are not allowed to resume.

Discussion and possible future tasks

- If Prefecture's approach to GoJ's relevant authorities to lift restrictions needs support (wild animal's flesh, wild mushroom), the IAEA is expected to provide technical advice and assistance, concerning existing international practice

- The IAEA informed about existing effort towards reference levels to be used in international trade, which may also eventually serve for national decisions

Information Dissemination Session

Topics

- IAEA' s assistance on information dissemination interlinks with all the areas and activities of cooperation:
  - remediation of the environment
  - management of radioactive waste
  - radiation monitoring

Key points

- IAEA's assistance was provided on effective ways to communicate information to the public in a timely and understandable manner
- Methodologies and expertise provided were based on global experience in dealing with accidental releases
- The most efficient way of getting messages across is to move away from one-way information dissemination to engagement of stakeholders
- Concrete communication products were developed in order to better inform audiences about radiation levels, risks and the radiation levels in the Prefecture
- The Prefecture websites has been revised in line with IAEA recommendations, for better user experience, higher search engine optimization therefore for higher impact
- Google Analytics tool was used to obtain quantitative data on visitor rate, retention, revisiting rates, drill down and bounce rates

Key points

- An important task is to increase trust of the general public in the Prefecture itself, in Japan and abroad, enabling them to make informed opinions
- Requires definition of target audiences, appropriate communication goals and tools and messages
- It is essential to communicate accurate messages to the target audience without using too specific scientific concepts
- To make outreach products easily understandable it was recommended to simplify language and to use infographics, graphs, animations, videos, etc.
- Lessons learned were: to simplify information presented on the page of the website, to build information architecture/taxonomy, include more actionable items on main page (surveys, videos…), to focus on fresh news on regular basis

Key points

- Radiation Safety Navigator was introduced as the new IAEA's online tool for effective communication about radiation safety. This tool can be utilized by the Prefecture, for example, in conveying messages about radiation doses.

Discussion topics

Involvement of citizens

- Was there any involvement of the citizens in measurement of radiation? As a result of citizen's need, municipalities distributed dosimeters to the citizens so that they can measure radiation doses in the area.

Searching feedback

- Was there any feedback from mushroom pickers/distributors and hunters on the brochures developed for them? The Prefecture is in the process of receiving feedback. Every year the content of these brochures will probably need be revised.

Expansion of currently available brochures

- Could an option to expand current series of brochures could be creating additional brochure on for example the wild plants?

  → Prefecture's standpoint

  - Prefecture has already posted information about wild plants on website.
  - Unlike wild mushrooms, there is no plan to make and publish brochure regarding distribution restrictions on edible wild plants as it is complicated.

Currently available information

- ✓ IAEA website

https://www.iaea.org/topics/radiation-protection/cooperation-fukushima-prefecture

- ✓ Prefecture website

https://www.fukushima-kankyosozo.jp/research.html

https://www.fukushima-kankyosozo.jp/eng/index.html

Summary Reports (2013～2022)

- The IAEA and the Prefecture are currently working together on summarizing results of 10 years cooperation and future plans
- To be summarized as “Summary Reports”
- Both in English and Japanese
- Both FCP and FIP
- To be published in the websites of the IAEA and the Prefecture in spring 2023

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Thank you very much for your kind attention!