# FY2014 Decontamination Report

- A compilation of experiences to date on decontamination for the living environment conducted by the Ministry of the Environment -

(Tentative Translation)

March 2015

Ministry of the Environment

Tentative Translation

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This material was translated temporarily and might be corrected in the future.

# Introduction

Radioactive materials were released by the accident at the Fukushima Daiichi Nuclear Power Station (1FNPS) after being hit by the Great East Japan Earthquake and ensuing Tsunami on March 11, 2011. The Government of Japan as well as prefectural and municipal governments have been taking measures to decontaminate the contaminated soil and wastes (hereinafter referred to as “decontamination”), in order to reduce the impact of radioactive materials on human health and the living environment as soon as possible.

In the efforts for the decontamination, all available resources including those from the central and local government offices, research institutions, and private cleaning operators have been put together, along with the most recent scientific and technical knowledge available from Japan and abroad. Of course it is the most important for the world never to repeat such a disaster in the future. In the meantime, disclosing and sharing our knowledge, experiences, and lessons obtained through the decontamination efforts at this time with domestic peers and the international community will be significant to accelerate the decontamination work in Japan and minimize the potential damage in future accidents in the world for the implementation of expeditious and efficient decontamination.

Therefore, in this Decontamination Report (hereinafter referred to as “the report”), the Ministry of the Environment (MOE) has comprehensively compiled the basic policy of the decontamination and implementation framework, knowledge about the management of decontamination projects based on the actual decontamination operations on-site, together with the procedures, conditions and effects of individual decontamination techniques, by mainly focusing on the decontamination operations performed by the MOE. Thus, this report is deemed to be a fundamental document to disseminate both domestically and internationally our experiences, lessons and knowledge learned through the decontamination efforts.

The report consists of the following seven chapters:

1. Basic features of the environmental decontamination in Japan
2. Overview of decontamination methods
3. Management and treatment of decontamination wastes
4. Management of decontamination projects
5. Effects of decontamination
6. Overview, usage and conditions of decontamination technologies and verification of their effects
7. Conclusion

Chapter 1 describes the history and background of the demonstration projects, the contamination status of decontaminated areas and features of the demonstration projects. Chapter 2 outlines the process to establish decontamination procedures and decontamination methods on the basis of the MOE’s document “Decontamination Guidelines (2nd Ed., 2013)” Chapter 3 explains the management and treatment of removed soil and wastes derived from decontamination works with examples of temporary storage sites, disposal and treatment of water used for decontamination works and volume reduction for burnable wastes. Chapter 4 illustrates operation planning for a large range of decontamination projects, including such example tasks as acquiring stakeholders’ consent, having effective communication with residents, managing the projects and providing radiation protection, education and health care for decontamination workers. Chapter 5 presents a wide range of area-wide decontamination effects and their evaluation approach. Chapter 6 explains decontamination methods and their effects from a technical viewpoint on the basis of data obtained in test decontamination works in order to demonstrate findings on the effects of individual decontamination technologies used in the full-scale decontamination works. Chapter 7 summarizes the main points of the report.

It is the expectation of the MOE that this report will facilitate more effective and efficient decontamination works in the environmental remediation after the accident at the 1FNPS, and contributes to preparations for potential nuclear accidents and related research worldwide.

## Contents

# 1. Basic features of the environmental decontamination in Japan

The decontamination projects associated with the accident at the Fukushima Daiichi Nuclear Power Station (1FNPS) of Tokyo Electric Power Co., Inc. (TEPCO) have the following basic features involving the status of environmental pollution, geographical factors, and the stance of the national and the local governments toward residents.

- The principal radionuclide causing environmental pollution is cesium.
- Decontamination should be conducted to reduce the impact on human health or the living environment not only in housing areas and public facilities, but also in diverse and wide areas including roads, farmlands, forests around the living space, and the like.
- Decontamination should be implemented as soon as possible for early return, safety protection and life rebuilding of residents in the evacuated areas.
- Residents' opinions and their way of life should be respected; decontamination should be conducted by paying due consideration to the protection of private rights and maintenance of the community.

Hereinafter, the history and the background of decontamination, the status of the radioactive contamination, and features of decontamination works are given in the following parts 1.1, 1.2 and 1.3, respectively, which led to the formation of the above characteristics.

## 1.1. History of the environmental decontamination

### 1.1.1. Specific features of the decontamination in Japan and Fukushima Prefecture

In Japan, about two-thirds of the country is occupied by forests, and the proportion of the inhabitable land areas limited to about the remaining one-third. Therefore, the population density in inhabitable land tends to be high. In addition, as Japan is the only nation to have been hit by nuclear bombs, the Japanese people have a stronger interest and greater concern than the people of other countries toward the damage caused by radiation. On the other hand, knowledge about radiation and its influence on the human health had not been shared sufficiently among ordinary person, before the Great East Japan Earthquake.

In Fukushima Prefecture, which most strongly received the effects of the nuclear power plant accident, the population in October 2010 was about 2 million people and the total area is approximately 14,000 square kilometers. While this is a vast land area, it is used in various forms. The utilization ratio of the land[1] is: forests, about 70 %; agricultural land, about 11%; the surface covered with water bodies, rivers and waterways, about 3 %; and roads and residential land, about 4%. The east side of Fukushima Prefecture faces the Pacific Ocean, and the west side is surrounded by mountains. Therefore the situation of the four seasons is quite different between in the eastern and western regions of the prefecture. In 2014, Fukushima City, located in the central region, had 96 snowfall days and the number of days was relatively large in Japan. Based on these specific circumstances in Japan and Fukushima Prefecture, most appropriate decontamination activities are due to be carried out.

### 1.1.2. History of the principal events associated with decontamination

#### (1) Occurrence of the accident at the nuclear power station and evacuation of residents

At 14:46 on March 11, 2011 (Japan time, hereinafter all times are this), an earthquake occurred off the Pacific Coast of northeast Japan. The earthquake and ensuing tsunami damaged facilities of the Fukushima Daiichi Nuclear Power Station (1FNPS) and the Fukushima Daini Nuclear Power Station (2FNPS) of Tokyo Electric Power Co., Inc. (TEPCO), setting the stage for an unprecedented complex nuclear accident that led to releases of substantial amounts of radioactive materials to the atmosphere from the 1FNPS.

[1]Source: Fukushima Prefecture, "2014 edition, Recording of the main data in Fukushima Prefecture" (http://www.pref.fukushima.lg.jp/sec/11045b/26youran.html)

Then Prime Minister Naoto Kan declared a nuclear emergency situation at 19:03 on March 11, 2011, and established the Nuclear Emergency Response Headquarters (NERH) within the Prime Minister's Office according to the Act on Special Measures Concerning Nuclear Emergency Preparedness (Law No. 156, 1999).

In the meantime, the Fukushima Prefectural Government set up the prefectural headquarters for disaster control. Upon receipt of the declaration of a nuclear emergency situation at the 1FNPS, at 20:50 on March 11, 2011, the Governor of Fukushima ordered Okuma and Futaba Towns to evacuate the residents living within the radius of 2 km from the 1FNPS.

At 21:23 on March 11, 2011, the NERH ordered the Fukushima Governor and other relevant authorities of the municipalities to evacuate the residents living within the radius of 3 km from the 1FNPS and to order those living within the radius of 10 km from the 1FNPS to remain indoors. Then, on March 12, 2011, the NERH ordered the Fukushima Governor and other relevant municipalities to evacuate all residents living within the radius of 20 km from the 1FNPS.

Later, following the hydrogen explosion at Unit 3 and others on March 14, the NERH on March 15, 2011, ordered the Fukushima Governor and relevant authorities of the municipalities to instruct the residents living in an area between the radius of 20 km and 30 km from the 1FNPS to remain indoors.

On March 17, 2011, the Ministry of Health, Labour and Welfare (MHLW) set the index values[2] on food and drink intake limit of radioactive materials as provisional regulation values of the Food Sanitation Act, and began the radioactivity monitoring of foods[3].

On March 19, 2011, radioactivity exceeding the provisional regulation values of radioactive materials in foods were detected in certain areas in spinach and raw milk, etc., and in response to this situation, the NERH summarized a "Monitoring plan, and a policy on setting and lifting of the food items and the areas to be subjected to shipment restrictions, etc.". In addition, concerning the planting of rice which is a staple grain food in the Japanese diet, the NERH presented on April 8, 2011, "The policy on planting of rice", and took measures for foods, such as imposing planting restrictions on rice in places where the radioactivity of the produced rice was more likely to exceed the provisional regulation values[4].

In addition, on April 21, 2011, the NERH announced to the Fukushima Governor and the mayors of other related municipalities that it had designated the area located within the radius of 20 km from the 1FNPS as the restricted area, in order to secure the complete safety of residents.

Some evacuees thought that the evacuation was a "temporary refuge of around several days" at the beginning of the disaster occurrence. However, after about 1 month, concerns about the prolonged evacuation life became tangible, and feelings of anger and anxiety spread among evacuees.

### (2) Understanding the status of the environmental contamination based on monitoring data and zoning of the evacuation areas

The monitoring data by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) showed areas with high accumulation of radioactive materials in the areas located beyond the radius of 20 km from the 1FNPS. On April 22, 2011, the NERH announced to the mayors of local municipalities that it had newly designated such areas located beyond the radius of 20 km from the 1FNPS as the deliberate evacuation area. In addition, the area between the radius of 20 km and 30 km from the 1FNPS, formerly designated as the sheltering area was designated as the “evacuation-prepared area in case of emergency,” excluding the above “deliberate evacuation area.” The above designation requested the residents in the deliberate evacuation area to schedule their departure from the area, and the residents in the evacuation-prepared area in case of emergency to prepare for evacuation or shelter indoors in case of emergency. In addition, there were certain spots outside the deliberate evacuation area where substantial air dose rates continued to be found and so the annually cumulative exposure dose one year after the accident

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[2] Source: Ministry of Health, Labour and Welfare(MHLW), "Handling of radioactively contaminated food" (March 17, 2011)

[3] The provisional regulation values set on March 15, 2012 are not values established for the emergency response after the accident, but are new values determined from the long-term perspective.

[4] Source: Ministry of Agriculture, Forestry and Fisheries (MAFF), “White Paper on Food, Agriculture and Rural Areas: 2011" (April 24, 2012)

was anticipated to exceed 20 mSv. On June 16, 2011, the NERH designated such locations as “specific spots recommended for evacuation,” by announcing the policy of raising awareness and supporting and promoting the evacuation of residents[5].

On August 3, 2011, the Ministry of Agriculture, Forestry and Fisheries (MAFF) published the "Basic policy on investigation of radioactive materials in rice," and decided to investigate radioactive materials in rice, a stable food in the Japanese diet, at two stages the “preliminary investigation" before harvesting the crop and the "main investigation" after harvesting it[6]. In addition, the MAFF carried out a survey of the radioactive contaminants that targeted a total of about 580 points in Fukushima Prefecture and five surrounding prefectures, and published a concentration distribution map of the radioactive materials in agricultural soil[4].

On August 9, 2011, the NERH announced its concept for the review of the evacuation areas[7]. The announcement stated the evacuation orders had substantial impacts on the lives of residents and it would be appropriate to review the orders, once the status changed because of confirming such as the verification of safety of nuclear reactor facilities and reduction of dose rates through continued monitoring.

Even outside the evacuation area, contamination was found. Also, it became apparent that evacuation had to be inevitably prolonged. Under this situation, some evacuees moved farther from the 1FNPS. Some residents even in non-evacuation areas also moved away farther on their own decision.

Residents were highly worried about the radioactive contamination of the living environment. They proactively collected information about radioactive materials and the status of contamination by themselves because of limited availability of relevant information. As a result, diverse information was circulated regardless of its quality via SNS and other means. In such a situation, prefectural, municipal, and community officials who needed to directly communicate with residents made efforts to soothe the confusion between residents by actively providing residents with the latest information and advice on radiation protection. They had to so act, while responding to the disaster and confirming safety and location of residents, by referring to the information provided by the national and prefectural governments and opinions of experts with whom they had personal contacts, They also lacked sufficient information.

On September 30, 2011, MEXT announced the “Results of nuclide analyses of plutonium and strontium”. These results showed that the effects of plutonium and strontium exposure were much lower in comparison with that of cesium, confirming that the primary concern should be cesium.

The total number of evacuees in the whole of Fukushima Prefecture was about 164,000 at its peak as shown in figure 1-1. The number of evacuees from the evacuation order areas reached 81,000 as of August 8, 2013. Considering that the population in Fukushima Prefecture as of October 2010 was about 2,000,000 as stated in 1.1.1, it can be understood how a lot of people evacuated.

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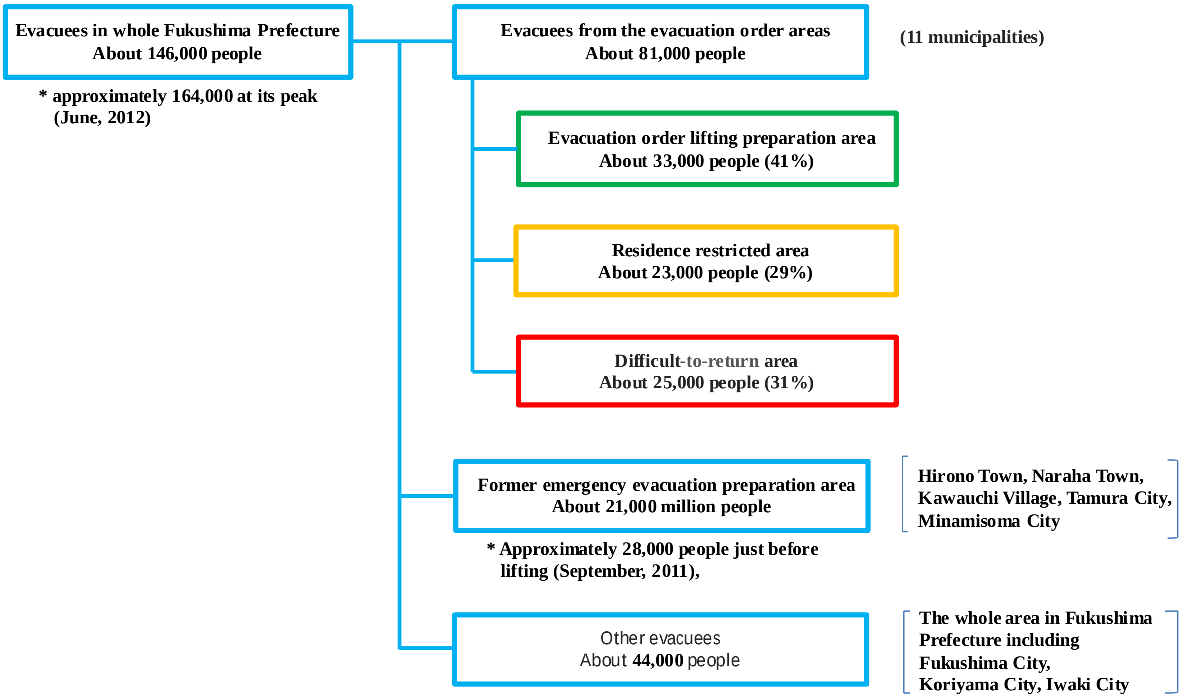
[5]Source: Nuclear Emergency Response Headquarters (NERH), “Addressing the specific spots where the cumulative exposure dose one year after the accident is expected to exceed 20 mSv” (June 16, 2011)

[6]Furthermore, the concentration of radioactive cesium exceeding the provisional regulation values was detected in rice from certain areas after the survey, so rice shipment restrictions were enforced in those areas.

[7]Source: Nuclear Emergency Response Headquarters(NERH), “Concept of the review of the evacuation areas” (August 9, 2011)




(Remarks)

・The refugees from the whole Fukushima Prefecture are based on the damage information bulletin (Part 1031) (September 17, 2013) of the Fukushima Prefecture "Tohoku – Pacific Ocean Earthquake, FY 2011".
・The number of refugees from the evacuation order areas was totaled by the Assistance of Residents Affected by the Nuclear Incidents based on the information caught from municipalities (the number of resident registration as of August 8, 2013).
・The number of refugees from the former emergency evacuation preparation area was totaled by the Assistance of Residents Affected by the Nuclear Incidents based on the information caught from municipalities (as of September 17, 2013).

Figure 1-1 The number of evacuees from the evacuation order areas[8].

## （3） Implementation of emergency measures

### 1） Formulation of response policy

Upon discovery of radioactive contamination even outside the evacuation order areas, emergency measures were also required there and various efforts were made accordingly.

Japan's Act on Special Measures concerning Nuclear Emergency Preparedness stipulated that it was the responsibility of the NERH to resonsd to the nuclear emergency and take post-accident measures in order to prevent the expansion of nuclear disaster and to promote the restoration activities. However, no practical legal framework covering such points as specific methods and framework to address the release of radioactive materials into the environment had been formulated before the accident occurred. Under this situation, the Government immediately formulated and announced provisional policies such as criteria for the treatment of disaster wastes[9], criteria for radiation protection[10], and dose criteria in schools to secure children's living environment[11].

In addition, because radioactive materials which exceeded the provisional standard values prescribed in the Food Sanitation Act were detected in tea leaves grown outside Fukushima Prefecture, the MAFF stopped the shipment of those products and conducted investigations[12].

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[8]Source: Cabinet Office, "Review of the evacuation instructions" (October 2013)

[9]Source: Ministry of the Environment (MOE), "Handling of disaster waste in Fukushima Prefecture for the time being" (May 2, 2011)

[10]Source: Nuclear Safety Commission, "The basic idea about radiation protection and decontamination" (May 19, 2011)

[11]Source: Ministry of Education, Culture, Sports, Science and Technology (MEXT), "Tentative ideas in judging the use of buildings and playgrounds of schools in Fukushima Prefecture" (April 19, 2011)

[12]Source: Ministry of Agriculture, Forestry and Fisheries (MAFF), "White Paper on Food, Agriculture and Rural Areas 2011" (April 24, 2012)

## 2）Decontamination activities started by various entities

Since the contamination had expanded outside the evacuation order area, some municipalities started their own efforts to reduce radiation exposure. Initially, the emphasis was placed on reduction of children's exposure to radiation.

The pioneers were Date City and Koriyama City. Date City started a demonstration test at a school ground of former Shimooguni Elementary School from April 21, 2011[13]. Koriyama City began to remove topsoil of school grounds from April 27, 2011[14]. In May 2011, a group of experts on radiation from the Japan Atomic Energy Agency (JAEA), in cooperation with Fukushima University, conducted the field survey to verify the reduction measures of air dose in schoolyards and kindergarten yards[15]. As a result, two soil treatment methods were presented: one was to collectively bury soil underground and the other was to vertically displace soil (upside-down plowing (deep plowing)). JAEA then continued monitoring the effectiveness of the dose reduction activities at not only school grounds but also at school swimming pools in municipalities. They also cooperated in the formulation of decontamination guidelines based on their expert knowledge (In those days, the term “decontamination” was not in common use; rather the term “dose reduction activity” was used.)

In addition, experts with knowledge of radiation played the role of decontamination advisors for several municipalities such as Date City, Minamisoma City, and Iitate Village to start decontamination activities (Figure 1-2 shows decontamination work in Date City).

Each municipality, whick lacked knowledge on radiation and sufficient personnel for decontamination conducted dose reduction activities and model decontamination projects[16] by themselves, using available tools, in cooperation with organizations and experts with knowledge of radiation and sometimes with volunteers. These efforts mainly targeted local facilities (or points) such as schools and specific houses. On the other hand, the notion was gradually spread that decontamination of wide area was necessary to obtain sufficient effects in air dose rate reduction.

Under these circumstances, to verify the effects of decontamination over relatively wide areas with various land usage including housing, roads, agriculture, etc., the Cabinet Office entrusted JAEA to start a demonstrative test in Date City and Minami-soma City under a “research project to formulate decontamination guidelines related to the accident at the 1FNPS”. In addition, to verify technologies for area-wide decontamination, the Fukushima Prefecture implemented a wide-area decontamination model project.[17] In the meantime, different range and effects of decontamination among municipalities led to "sense of unfairness" and "sense of dissatisfaction" of some residents.

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[13]Source: Date City, “Three years of history of Date City after the Great East Japan Earthquake and Nuclear Accident” (http://www.city.date.fukushima.jp/soshiki/9/7146.html)

[14]Source: Koriyama City, “History of Koriyama City after the Great East Japan Earthquake” (February 2013)

[15]Source: Ministry of Education, Culture, Sports, Science and Technology (MEXT), “Air dose reduction measures in the schoolyards and kindergarten yards based on fieldwork” (May 11, 2011)

[16]For example, the Fukushima Prefectural Government's model project for radiation reduction measures for ordinary houses

[17]Source: Fukushima Prefectural Government, Fukushima surface decontamination model project (https://www.pref.fukushima.lg.jp/sec/16045c/josen-mentekimoderu.html )

Figure 1-2 Decontamination at Tominari Elementary School in Date City.

| Target spots for the decontamination | | Area (㎡) |
|---|---|---|
| Residential land | Roof | 4,779 |
| | Wall | 5,945 |
| | Garden, etc. | 11,204 |
| Rice paddy | Rice field | 11,350 |
| Field, Orchard, etc | Field, Orchard | 27,325 |
| | Surface of slope | 20,705 |
| Forest, etc | Forest, Bamboo forest | 16,339 |
| Road | Municipal road | 6,866 |
| | Private road, Farm road | 148 |
| | Waterway | 565 |
| | Others | 89 |
| Total | | 105,315 |

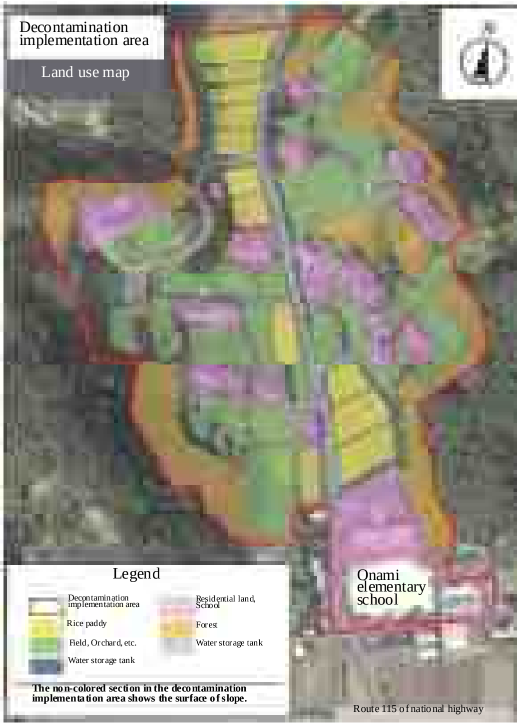


Figure 1-3 Target areas for decontamination of the area-wide decontamination model project by Fukushima Prefecture[18].

JAEA continued enhancing its framework to support the decontamination of each municipality. In addition, since October 2011, Fukushima Prefecture held workshops, in cooperation with JAEA, to develop human resources for decontamination.

At the municipal level, Fukushima City created the manual mentioned in 3) and held workshops for decontamination business operators, in order to develop human resources as well as to provide matching opportunities for local business operators to utilize their own techniques to let them easily enter the decontamination business[19].

[18]Source: Fukushima Prefecture, "Fukushima Prefecture surface decontamination model project summary version", (February 2012)

[19]For example, through the workshop, a company specializing in painting and cleaning was found to be good at high-pressure water cleaning, a company specializing in civil engineering was found to be good at

Apart from the above, regarding farmland, since May 28, 2011, MAFF took the initiative to conduct demonstration tests, as seen in Figure 1-4, to verify decontamination technologies for farmland soil in Iitate Village and Kawamata Town. On September 30, 2011, MAFF compiled the publication, “Appropriate Methods for Decontamination of Farmland.” The results of these demonstration tests are included in the decontamination-related guidelines described in (4) 2) of this chapter.

MAFF continued efforts to develop decontamination methods. It started demonstration project for development of farmland decontamination technologies in February 2012[20] including verification at the construction demonstration level and studies toward practical use in the field as shown in Figure 1-5. In February 2013, MAFF compiled the “Technical Book for Farmland Decontamination,” summarizing the features of each method as shown in Figure 1-6.

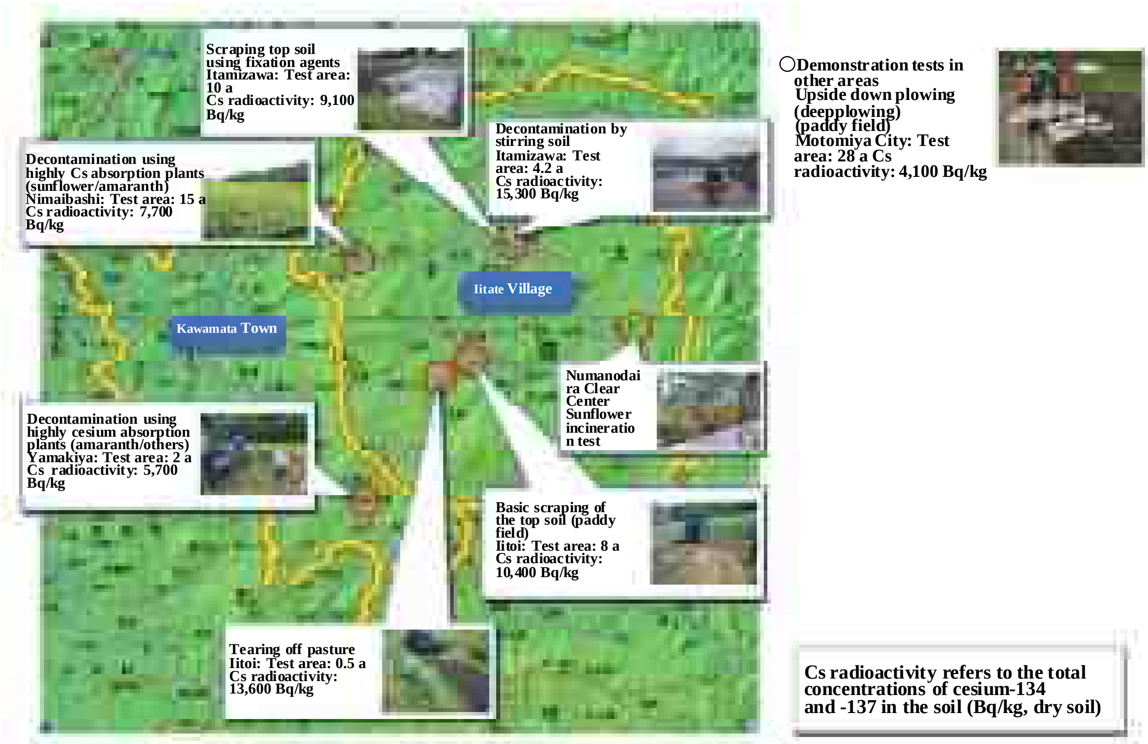


**Figure 1-4 Development of decontamination technologies for contaminated agricultural soil – Overview of the demonstration tests[21].**

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scraping of ground soil.

[20] Source: Ministry of Agriculture, Forestry and Fisheries (MAFF), “Results of the Demonstration Project for Decontamination of Farmland (Interim Report)” and the “Technical Book for Farmland Decontamination” (August 31, 2012)

[21] Source: Ministry of Agriculture, Forestry and Fisheries (MAFF), "Development status of decontamination technology in agriculture, forestry and fisheries" (June 16, 2012), (also the source for Figure 1-5)

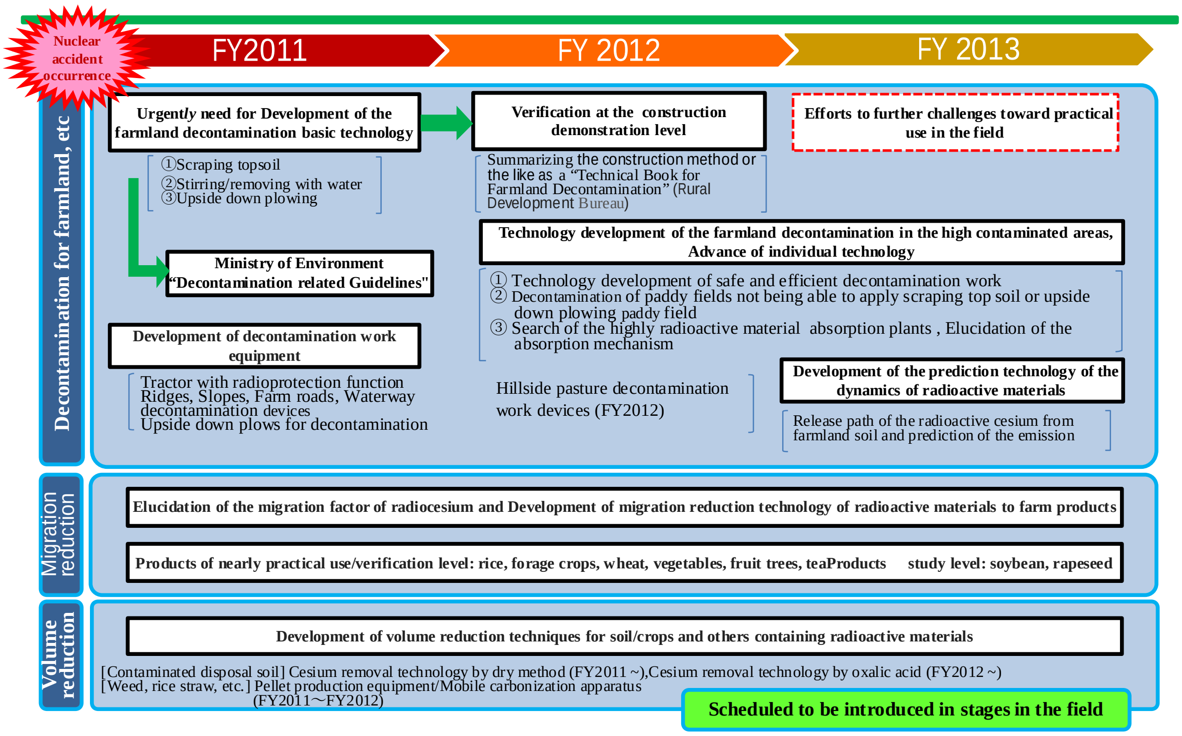


Figure 1-5 Research plan of radioactivity decontamination measures for agriculture after the nuclear accident.

| Process | Scraping methods | Feature | Soil water condition | Surface condition | Device versatility | Operator dependence |
|---|---|---|---|---|---|---|
| Scraping | Scraping the topsoil with backhoe | Scraping the topsoil by moving bucket back and forth with backhoe | Wet~Dry | Rough~land leveling | High | High |
| | Wiper | Scraping the topsoil by letting an arm swing to a horizontal direction using the backhoe fitted an edge to the bucket | Wet~Dry | Rough~land leveling | Middle | Low |
| Collecting/Transporting | Standard transporting | Packing the scraped soil into the weatherproof large sandbags using backhoe and carry it | Wet~Dry | — | High | — |
| | Sucking | Sucking the scraped soil through suction pump/hose using the sludge supply and discharge car | Dry | — | Middle | — |
| | Conveyor | Packing the scraped soil into the weatherproof large sandbags using the screw conveyor type shaving machine | Dry | — | Low | — |
| Scraping~Collecting/Transporting(continuous) | Skimmer | Scraping the topsoil with horizontally rotating special resin plate and loading the scraped soil into a followed truck for the non-leveling of ground | Dry | land leveling | Low | Middle |
| | Turf stripper | Scraping the topsoil by letting a lot of small scoop-shaped blades rotate horizontally and loading the scraped soil into a truck running parallel for the non-leveling of ground | Dry | land leveling | Low | Middle |
| | Rotary cutter | Scraping the topsoil using the lawnmower with the rotary feather fixed to a backhoe and packing the scraped soil into the weatherproof large sandbags in the rear | Dry | land leveling | Low | Middle |

Figure 1-6 Options of topsoil scraping methods[22].

[22]Source: Ministry of Agriculture, Forestry and Fisheries (MAFF), "Overview of the Technical Book of Agricultural Land Decontamination Measures" (February 2013)

### 3）Formulation of manuals for radiation dose reduction measures

As mentioned in 1.1.1, the knowledge of radiation and about its influences on the human body had not been shared sufficiently among ordinary people in Japan before the accident occurred. The accident raised the need for general knowledge on radiation and for information on radiation protection measures for the accident at 1FNPS, especially among people in the affected areas. Several academic organizations with expert knowledge of radiation published Q&A-style radiation guidebooks to provide basic knowledge and information on radiation to the public[23]. The Government and Fukushima Prefecture also issued some pamphlets regarding radiation.

In addition, Fukushima Prefecture, Minami-soma City, and Fukushima City published several manuals for radiation dose reduction measures[24], which contributed to provide people with knowledge not only on radiation but also on decontamination.

Based on these guidelines as well as the results of decontamination activities shown in 2) just above, some municipalities formulated and announced their first decontamination implementation plans based on the "Basic Policy on Urgent Implementation of Decontamination" (to be explained in the following (4)) as early as in the autumn of 2011[25].

The government incorporated the contents of these manuals issued by Fukushima Prefecture and municipalities and the knowledge obtained through decontamination activities including model projects into the "Decontamination Technology Catalog" and the "Decontamination Guidelines" as indicated in (4) 2).

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[23]For example, "Radiation Q&A in Life Answered by Experts" issued by the Japan Health Physics Society, "The Q&A Regarding Radiation Exposure" issued by the Japan Radiological Society, and "The Q&A Regarding the Impact of Radiation Exposure on the Human Body in Association with the 1FNPS Accident" issued by the Japanese Radiation Research Society.

[24]Examples are: Guidance for Reduction of Air Dose in Living Space issued by the Fukushima Prefectural Government (July 15, 2011), Radioactive Material Decontamination Manual issued by the Minami-soma Municipal Government (July 2011), and the Fukushima City Decontamination Manual (1st Ed.) issued by the Fukushima Municipal Government (September 27, 2011).

[25]For example, Date City Decontamination Implementation Plan (1st Ed.) (October 2011); Fukushima City Furusato Decontamination Implementation Plan (September 27, 2011);

Kawauchi Village Decontamination Implementation Plan (1st Ed.) e (September 28, 2011); and Minami-soma City Decontamination Plan (1st Ed.) (November 10, 2011)


**Figure 1-7 Excerpt from a brochure on radiation (left) and a guide book on decontamination (right) published by Fukushima Prefecture[26].**

## （4） Establishment of legal framework and decontamination guidelines

### 1）Framework of decontamination under the Act on Special Measures and others

While the knowledge about radiation and decontamination was gradually being collected and assembled, as described above, Chairperson of the Environment Committee of the lower house of the Diet presented a bill of the Act on Special Measures Concerning the Handling of Environmental Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District Off the Pacific Ocean Earthquake That Occurred on 11 March 2011 (Law No. 110, 2011) (hereinafter referred to as the Act on Special Measures). The Act was enacted on August 26, 2011 at the upper house plenary session and promulgated on August 30, 2011.

The NERH decided、on August 26, 2011, the Basic Policy on Urgent Implementation of Decontamination[27] as an initiative until the full enforcement of the above act (due January 1, 2012).

The above basic policy stipulated: the decontamination should be operated by the national government for the evacuation areas;, the annual additional exposure dose should be limited to 1 mSv or lower as a long term goal in the region under existing exposure situation (currently 20 mSv or lower for the annual additional exposure); and the national government should provide technical and financial support for local municipalities to develop and implement their decontamination plans. In addition, a fund was created by the supplementary budget of the Cabinet Office to let Fukushima Prefecture subsidize (at a

[26]Source: Fukushima Prefecture, "To understand radiation correctly and behave properly" (September 2011), and "Guidance related to radiation dose reduction measures in the living space" (July 15, 2011)

[27]Source: Nuclear Emergency Response Headquarters (NERH), Basic Policy on Urgent Implementation of Decontamination (August 26, 2011)

subsidy rate of 100%) the municipalities for decontamination based on their decontamination plans in accordance with the Urgent Implementation Policy.

The same basic policy further stipulated that the national government should continuously provide technical information necessary for the decontamination such as, on effective methods, their cost, and considerations due (the Decontamination Technology Catalog), through model projects in each area, including particularly high dose areas. In this regard, the NERH presented the “Guidelines for the Implementation of Decontamination in Municipalities [28]” for relevant municipalities to formulate and implement their decontamination plans.

On November 11, 2011, the Basic Principles on the Act on Special Measures was authorized by the Cabinet. Taking over the concept of the Basic Policy on Urgent Implementation of Decontamination Works, the new Basic Policy stipulated that the annual additional exposure dose would become below 1 mSv in the long-term in the area where the annual additional exposure dose was currently below 20 mSv, and that the national government was responsible for treating the wastes and wastewater sludge exceeding a certain level of radioactivity.

In the meantime, on October 29, 2011, the MOE announced the “Basic Concept of the Interim Storage Facility (ISF) Necessary in Dealing with Environmental Pollution Caused by Radioactive Materials in Association with the Accident at the 1FNPS of TEPCO,” which stipulated the policies to install the interim storage facility at one location in Fukushima Prefecture for handling contaminated soil and wastes produced in the prefecture and to finally dispose of such waste outside Fukushima Prefecture within 30 years after starting of interim storage.

On December 22, 2011, the MHLW promulgated the “Ordinance on Prevention of Ionizing Radiation Hazards Associated with Decontamination Works to Decontaminate Soil and Wastes Polluted by Radioactive Materials Resulting from the Great East Japan Earthquake” (hereinafter referred to as the Ionizing Radiation Ordinance for Decontamination), a framework to prevent the ionizing radiation hazards associated with decontamination work.

By such legal arrangements, the legal framework for implementing decontamination work in Japan has been fixed.

### 2）Decontamination guidelines

On November 22, 2011, the Cabinet Office issued the “Decontamination Technology Catalog” and on December 14, 2011, the MOE formulated and published the “Decontamination Guidelines” that systematically compiled the decontamination methods in accordance with the Act on Special Measures. The guidelines based on the Act on Special Measures explained in an easy-to-understand manner the processes to survey and measure the extent of contamination, implement the decontamination, and collect, transport, and store removed soil associated with decontamination work (See Chapter 2 for details).

On December 22, 2011, simultaneously with the announcement of the Ionizing Radiation Ordinance for Decontamination, the MHLW formulated and announced the “Guidelines for Prevention of Radiation Hazards to Workers Engaged in Decontamination Works,” which are the guidelines to prevent health hazards to workers associated with decontamination operations.

On December 27, 2011, the MOE formulated and announced the “Waste Guidelines” (the guidelines for processing waste contaminated by nuclear accident-derived radioactive materials).

In March 2012, the MOE formulated and announced the “Guidelines for Addressing Localized Contaminated Spots by Radioactive Materials,” which are the guidelines summarizing the efficient locating methods, in-depth survey methods, and handling precautions of localized contaminated spots.

Most of the guidelines were thus developed toward the end of JFY2011. j

[28] Source: Nuclear Emergency Response Headquarters (NERH), Guidelines for the Implementation of Decontamination in Municipalities (August 26, 2011)

## (5) Efforts toward the full-fledged decontamination under a unified framework

### 1) Decontamination projects by the Cabinet Office

In response to the establishment of the Basic Policy on Urgent Implementation of Decontamination Works, the Cabinet Office entrusted the project for a decontamination model to JAEA. The project primarily targeted the areas with annual additional exposure dose exceeding 20 mSv and had the aims of establishing efficient and effective decontamination methods and measures of radiation protection for workers (started in November 2011; see 1.1.6 for details).

The Cabinet Office also delegated the project to demonstrate decontamination methods to JAEA, in order to publicly solicit new decontamination technologies that can be practicable and to evaluate their effectiveness.

### 2) Cold shutdown state of nuclear power station and rezoning of the evacuation areas

On December 16, 2011, the NERH judged that the safety of the entire power station was comprehensively secured by the achievement of the cold shutdown state of the reactors. Thus, it was confirmed that the target of step 2 in the roadmap, a state where "the release of radioactive materials came under control and the radiation dose was significantly suppressed," was achieved.

Under this situation, on December 26, 2011, the NERH compiled the "Basic Concept and Future Tasks in Review of the Restricted Areas and the Evacuation Order Areas after the Completion of Step 2"; the basic concept to start a concrete review of the restricted areas and the evacuation order areas, including the preparation for lifting the evacuation order of the areas with low dose rates by further advancing the decontamination work, with the targeted time schedule to finish the review by March 30, 2012.

In response to the above, on January 26, 2012, the MOE announced the "Decontamination Policy of the Special Decontamination Area" (Decontamination Roadmap)," describing the flow of decontamination projects (demonstration model projects, preliminary decontamination, and full-scale decontamination) and the processes for each area.

As for lifting of evacuation orders, it was prescribed that development of livelihood infrastructures and restoration of municipal office functions should be promoted together with decontamination because the objective of lifting of evacuation orders was to assure returning of residents and reconstruction of their lives.

### 3) Establishment of a system toward full-scale decontamination

On August 24, 2011, before the establishment of the Act on Special Measures, the Fukushima Decontamination Promotion Team was established mainly by the MOE in cooperation with the Cabinet Office and JAEA to support the formulation of decontamination implementation planning by municipalities in Fukushima Prefecture. The team started its operation in September 2011, immediately after the promulgation of the Act on Special Measures, in cooperation with the Nuclear Emergency Response Local Headquarters (hereafter referred to as the Local NERH)), to communicate and coordinate with municipalities and to help the formulation of decontamination plans (including dispatch of experts). The team also promoted the national decontamination model projects in twelve municipalities in the restricted area, deliberate evacuation areas, etc .

In academic and private sectors, in May 2011, the Atomic Energy Society of Japan (AESJ) established the "Clean-up Subcommittee[29]" to actively provide support to the restoration activities of environmental contamination by radioactive materials. In November 2011, the "Society for Remediation of Radioactive Contamination in the Environment (SRRCE)[30]," which was mainly dealing with the subject of

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[29]Source: Fukushima Special Project, Clean-up Subcommittee, Project Leader Tadashi Inoue, The objectives of the establishment of AESJ CU Subcommittee and its activities (January 20, 2013)

[30]Source: The Society for Remediation of Radioactive Contamination in the Environment (SRRCE) Website (http://khjosen.org/)

decontamination, and the “Technical Advisory Council on Remediation and Waste Management[31]” by industry groups, were established.

On January 4, 2012, upon the full enforcement of the Act on Special Measures, the MOE established the “Fukushima Environmental Restoration Office” as a base to promote decontamination and revive the natural environment in Fukushima Prefecture. To promote decontamination in the Special Decontamination Area, the office coordinates the operations with eleven municipalities in the same areas, implements decontamination projects, and coordinates or cooperates with the Local NERH. In addition it consults and coordinates plans and project details of decontamination implemented by municipalities in Fukushima, Miyagi, and Iwate Prefectures. The office has five branches in Fukushima Prefecture to provide detailed support to municipalities (in addition to the five branches, on December 5, 2014, the Hamadori Office for the Interim Storage Facility was fonded to address the issues of the interim storage facility)[32].

On January 20, 2012, the Decontamination Information Plaza was jointly established near Fukushima Station by the MOE and Fukushima Prefecture to play the role of base facility to provide the general public with information on decontamination and radiation and to dispatch registered experts. The structure toward full-scale decontamination was steadily being built. JAEA and AESJ dispatched expert personnel to the Decontamination Information Plaza and the Fukushima Environmental Restoration Office.

On March 12, 2012, TEPCO established an office under the organization of the Environmental Department in its Fukushima Office to monitor the environmental radiation by resident employees and to provide support for the decontamination efforts in Fukushima. From April 7, 2012, the Federation of Electric Power Companies of Japan dispatched decontamination experts to support the decontamination activities in Fukushima, in addition to providing personnel to the Decontamination Information Plaza upon request.

In addition, the Japan Society of Civil Engineers (JSCE) established the “Specific Theme Committee to Address Radioactive Waste” under the “Great East Japan Earthquake Special Committee,” to carry out full-fledged activities from the beginning of 2012[33]. In April 2012, the Japan Federation of Construction Contractors established the Decontamination Committee under the Electric Measures Special Committee to establish the framework to implement decontamination projects for the entire construction industry.

On January 1, 2013, TEPCO established the “Fukushima Revitalization Headquarters” and the Decontamination Promotion Office within it to provide further cooperation on decontamination.

As seen above, with the establishment of the Act on Special Measures, the efforts and roles of national, prefectural, and municipal governments were restructured. As their roles were more clearly defined (Fig.1-8) and as their features became to be more utilized, the entire structure in Japan was optimized, and systematic cooperation between industry and academia was accelerated.

In the meantime, from February 8, 2012, the Fukushima Prefectural Government held meetings of the Study Committee for the Basic Concept of Environmental Recreation Strategic Base[34]. The committee studied the establishment of the “Center for Environmental Recreation,” the base facility to address the restoration and recreation of the environment contaminated by radioactive materials, under close cooperation among Fukushima Prefecture, JAEA, and the National Institute for Environmental Studies (NIES). The center is scheduled to open in FY2016 (a part of the facility is opening in FY2015) to provide residents with information such as monitoring of environmental radioactivity, status of the environmental decontamination for the remediation and recreation of the environment, tracking movements of radioactive materials, research and evaluation of decontamination methods, and the results of monitoring and surveys, and in addition to provide education, training, and exchanges to develop creative power for Fukushima's future[35].

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31 Source: Technical Advisory Council on Remediation and Waste Management Website (http://tacrwm.jp/01_about/01_01_objective.html)

32 Source: Ministry of the Environment (MOE): "Fukushima environmental remediation office"

33 Source: Japan Society of Civil Engineers: JSCE Great East Japan Earthquake Special Committee - One Year of Activities, Achievements, and Proposal (March 2012)

34 Source: Fukushima Prefecture Website （https://www.pref.fukushima.lg.jp/sec/16035d/meeting-basicplan.html ）

35 Source: Center for Environmental Recreation Operative Strategy Meeting: Mid- and long term policy for the environmental recreation center (February 2015)

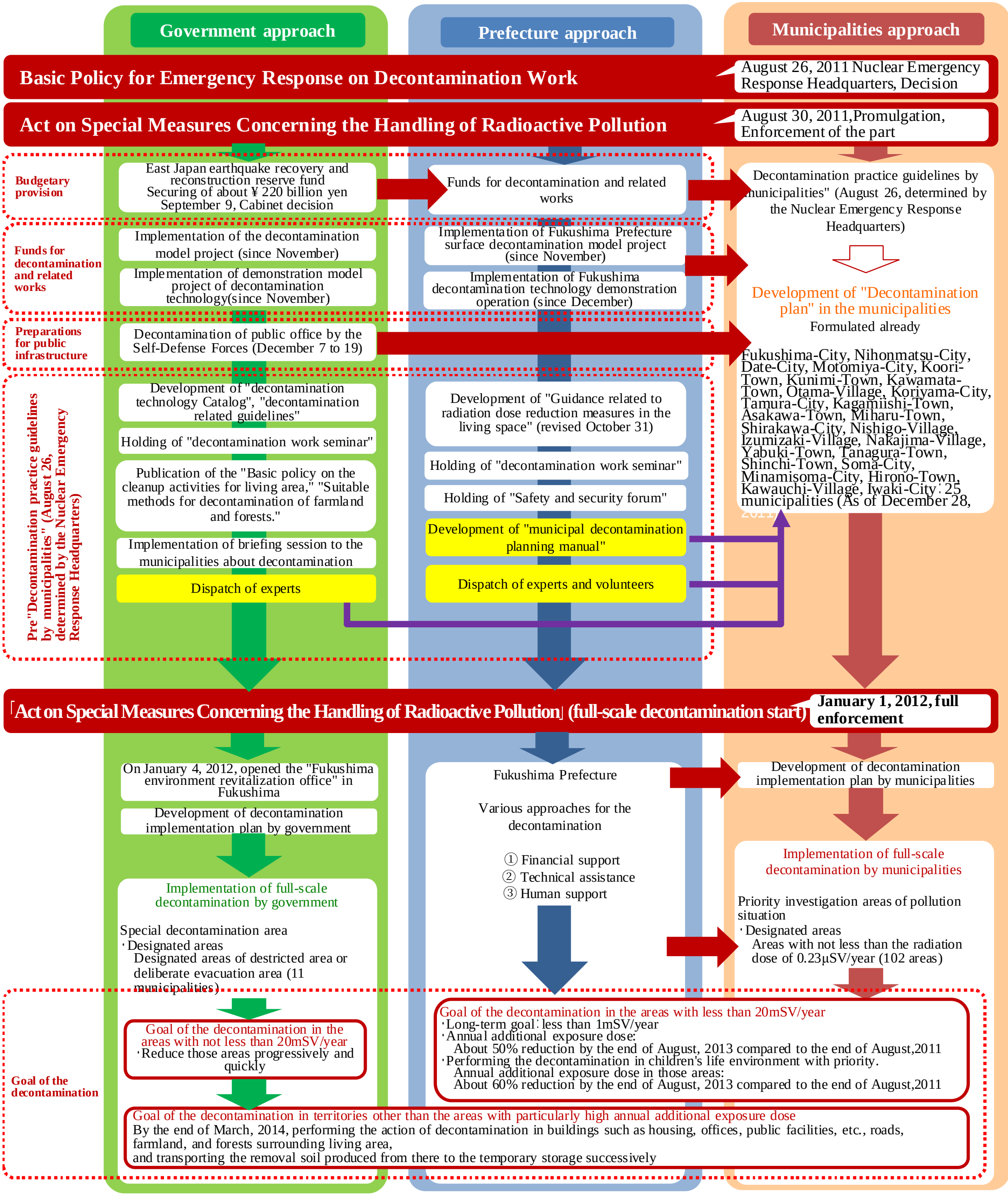


Figure 1-8 Decontamination approaches by government, prefectural and municipal authorities[36].

In October 2011, the International Atomic Energy Agency (IAEA) visited Fukushima, reviewed the decontamination works performed by Japan and provided advice on them. The results were compiled in the form of the “Final Report by the International Mission Regarding Remediation of Large Contaminated

[36]Source: The nuclear disaster victims life support team by the government: “Interaction with the public, newsletter No. 9 ‘ (News from the nuclear disaster victims life support team by the government)” (January 15, 2012)

Areas Off-site the Fukushima Daiichi Nuclear Power Plant." The report described nine areas of significant improvement and gave recommendations on twelve points to the Japanese government.

- Examples of nine highlights of important progress and recommendations on twelve points which were described in the Final Report[37] by the International Mission Regarding Remediation of Large Contaminated Areas Off-site the Fukushima Daiichi Nuclear Power Plant[38].

【Examples of nine highlights of important progress】

- The Mission Team appreciates that Japan has gone forward very quickly and allocated the necessary legal, economic and technological resources to develop an efficient remediation programme to bring relief to the people affected by the Fukushima Dai-ichi nuclear accident. Priority has been given to children and the areas that they typically frequent.
- The Fukushima Decontamination Promotion Team, which consists of resident staff in Fukushima from the Ministry of the Environment (MOE), the Local Emergency Response Headquarters and the Japan Atomic Energy Agency (JAEA), coordinates and shares information with relevant ministries and agencies, and communicates with and provides technical support to the Fukushima prefectural and relevant municipalities. The Mission Team welcomes Japan's efforts to establish a practical catalogue of remediation techniques
- The Team considers the use of demonstration sites to test and assess various remediation methods to be a very helpful way to support the decision-making process.

【Examples of recommendations on twelve points】

- The Japanese authorities involved in the remediation strategy are encouraged to cautiously balance the different factors that influence the net benefit of the remediation measures to ensure dose reduction. They are encouraged to avoid over-conservatism which cannot effectively contribute to the reduction of exposure doses. This goal could be achieved through the practical implementation of the Justification and Optimization principles under the prevailing circumstances. Involving more radiation protection experts (and the Regulatory Body) in the organizational structures that assist the decision makers might be beneficial in the fulfillment of this objective. The IAEA is ready to support Japan in considering new and appropriate criteria.
- It is appropriate to consider further strengthening coordination among the main actors, through the establishment of a more permanent liaison between the organizational structures of the Government of Japan and the prefectural and municipal authorities.
- Before investing substantial time and efforts in remediating forest areas, a safety assessment should be carried out to indicate if such action leads to a reduction of doses for the public. If not, efforts should be concentrated in areas that bring greater benefits. This safety assessment should make use of the results of the demonstration tests.

## (6) Progress of decontamination in the Special Decontamination Area and the Intensive Contamination Survey Area

### 1) Progress of decontamination in the Special Decontamination Area

The decontamination in the Special Decontamination Area (see 1.1.5 for details) was started from the peripheral areas of municipal offices by the Self-Defense Forces, which would serve as the bases for full-scale decontamination activities later. Also, the decontamination of

[37]Source: IAEA, "Final Report of the International Mission on Remediation of Large Contaminated Areas Off-site the Fukushima Daiichi Nuclear Power Plant" (November 15, 2011) (http://www.mofa.go.jp/mofaj/saigai/pdfs/iaea_mission_1110_en.pdf )

[38]Source: Excerpt from IAEA "Final Report of the International Mission on Remediation of Large Contaminated Areas Off-site the Fukushima Daiichi Nuclear Power Plant; Draft translation (Summary portion only)" (November 15, 2011)

future operational bases such as other public facilities was made by the MOE. Additionally, the decontamination model projects were started in March 2012 in the restricted area of the Joban Expressway, an important piece of transportation infrastructure. These activities were conducted as part of overall strategic efforts, which had the objectives of establishing effective decontamination methods, while obtaining data to help implement smooth large-scale decontamination, instead of just conducting large-scale decontamination without a strategy.

The progress in review of evacuation zoning differed by municipality in the Special Decontamination Area. On March 30, 2012, zoning in parts of the restricted areas in Tamura City, Kawauchi Village, and Minami-soma City were changed and these were newly designated as evacuation order areas. In April 2012, the MOE formulated decontamination implementation plans for Tamura City, Naraha Town, Kawauchi Village, and Minami-soma City, earlier than for other municipalities. On July 25, 2012, the MOE started the first full-scale decontamination in the Special Decontamination Area in Tamura City. Then, although there were differences in progress among municipalities in the Special Decontamination Area, the decontamination plans were gradually formulated, followed by full-scale decontamination.

According to the Act on Special Measures, the consent of a large number of concerned parties was required before starting the decontamination. It took a very long time to identify the land owners and stakeholders, to pay attention to residents' feelings, and to provide considerations and detailed explanations to obtain consent of all involved. Furthermore, with the large- and full-scale decontamination works having started, the operators were required to secure a large number of workers, provide education on labor safety and decontamination works, and secure qualified workers. Each operator made various efforts to address these mounting tasks. In the meantime, the national government kept collecting knowledge and information on new discoveries from actual decontamination works, shared the information with the public in a timely manner, and reflected such summaries in the form of specifications to the decontamination business operators (See Chapter 4 for details).

### 2）Progress of decontamination in the Intensive Contamination Survey Area

In the Intensive Contamination Survey Area (see 1.1.7 for details), some municipalities had already conducted the decontamination before the full enforcement of the Act on Special Measures. They utilized the knowledge obtained from their experiences and continued the decontamination after the enforcement of this Act.

For example, based on the experience that it was important to form a consensus with local residents before starting the decontamination, Fukushima City allowed the residents' involvement from the planning stage of decontamination as shown in Figure 1-9. The city established 18 “regional decontamination measure committees” consisting of officers of the autonomy promotion council, PTA, and local city council members. The city also conducted “decontamination implementation review meetings,” consisting of leaders of neighborhood associations to confirm the flow of rainwater and surface water in each community and study the work orders for decontamination. Minami-soma City made efforts to seek agreement among residents to secure temporary storage sites by establishing the selection criteria for candidate sites by themselves and explaining them to residents as shown in Table 1-1. In Kawauchi Village, dosimeters were distributed to all families, so that residents themselves were able to measure the dose before and after decontamination.

Such efforts to involve residents in the decontamination were also seen in several municipalities outside Fukushima Prefecture. For example, in Kashiwa City, Chiba Prefecture, the “Dialog Meeting toward Safe Living organized by the Association to Promote Decontamination in Kashiwa City[39]” was held during November 21-23, 2011, to have sufficiently long discussions with citizens. Consequently, the city formulated its

[39]Source: Kashiwa City Website（http://www.city.kashiwa.lg.jp/soshiki/080800/p010072.html）

decontamination implementation plan in March 2012[40]. In the case of Kashiwa City, as a result of the above efforts, the decontamination implementation plan allowed much involvement of citizens by stipulating enhanced support for citizens and volunteers in the decontamination implementation.

On the other hand, some municipalities were not able to establish temporary storage sites. Some took a long time to decide the scope of decontamination and the formulation of the decontamination implementation plan because they were not able to reach agreement with residents.

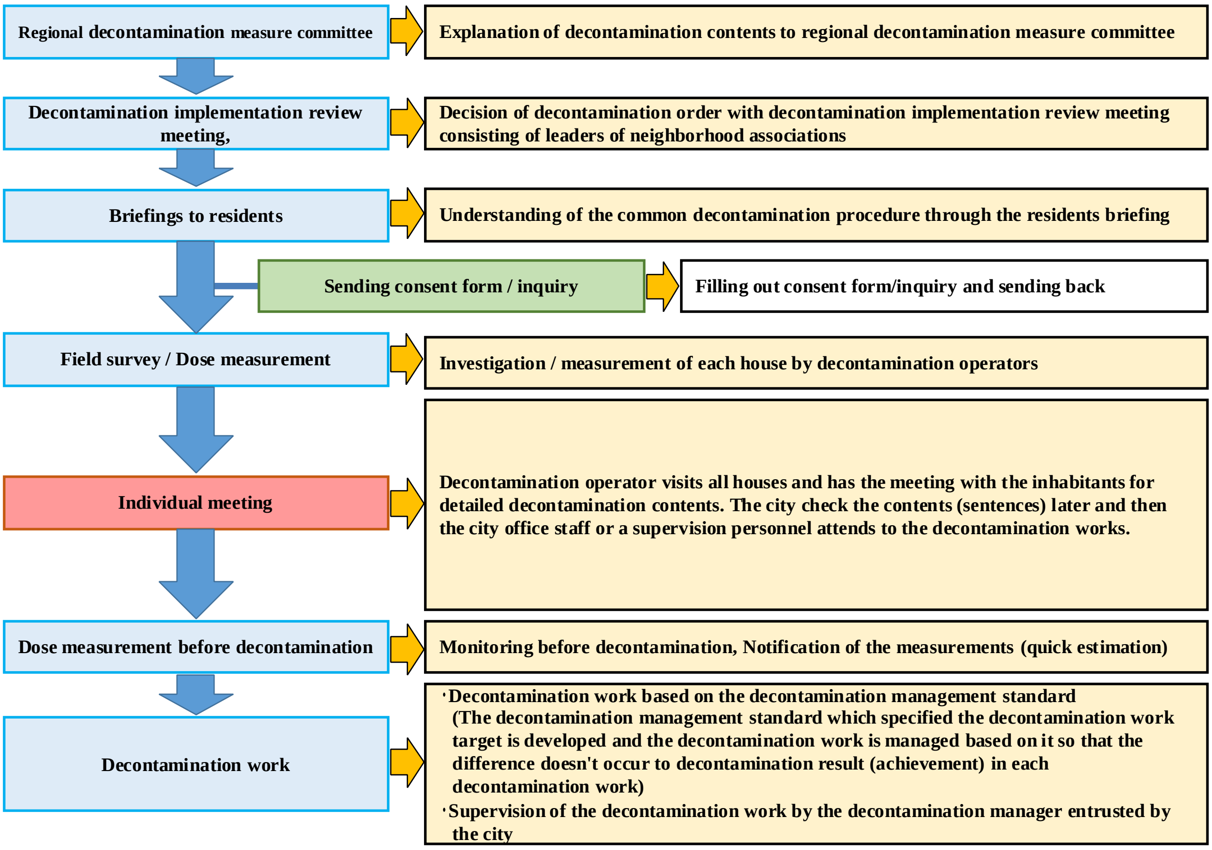


Figure 1-9 Procedure for housing decontamination (Fukushima City)[41].

[40]Source: Kashiwa City Website（http://www.city.kashiwa.lg.jp/soshiki/080800/p011077.html）

[41]Source: Fukushima City, "An approach to the decontamination in Fukushima City" (February 28, 2013)

Table 1-1 Criteria for selecting candidate site for temporary storage[42]

| Viewpoint | Items for selecting site | Criteria for electing site | Reason |
|---|---|---|---|
| Use of land | Securing of site area | Securing of site area not less than 10,000m$^2$ | Production of a large amount of removed radioactive substances |
| | Securing of access road | Securing of access road not less than two traffic lanes | Access of large vehicles and heavy industrial machinery, etc. |
| Environment protection | Distance from the surrounding housing, school and hospital, etc. | Distance between candidate site and the neighboring houses, school and hospital, etc. | Impact on consensus |
| | Risk of secondary disaster | Outflow of radioactive materials and geological feature | |
| | Influence of water quality, animals and plants | No influence on water quality, animals and plants. | |
| Cost performance | With or without site renovation | Preparation of sites suitable for storage and control of the removed soil | Impact on decontamination work schedule and project costs |
| | With or without site acquisition | Site acquisition in the case of non-public land | |
| Agreement | Land owner | Land owners' cooperation and understanding in the case of non-public land | Impact on decontamination work schedule |
| | Agreement with local residents | Cooperation and understanding of the surrounding residents | |

## (7) Efforts based on the experiences of decontamination

On October 23, 2012, the MOE compiled the “Decontamination Promotion Package,” in order to accelerate the decontamination works and eliminate anxiety among residents. The above package recommended measures to accelerate decontamination works, such as transfer of authority to the Fukushima Environmental Restoration Office, expansion of outsourcing of

[42]Source: Minami-soma City, "The situation of the decontamination in Minami-soma City" (October 22, 2013)

the negotiation of obtaining residents' consent to the private sector, and securing of decontamination workers from a wide area. Moreover, it further recommended the measures to obtain residents' consent and eliminate anxiety among residents, which was the major problem then, such as disclosure of information about the effects and progress of decontamination and strengthening of risk communication about decontamination.

Then, in November 2012, the "progress of decontamination in the Intensive Contamination Survey Area" was announced, and in March 2013, the "progress of decontamination in the Special Decontamination Area" was announced, more publicly disclosing the overall progress of decontamination.

In the meantime, in January 2013, one year after the full enforcement of the Act on Special Measures, upon receipt of reports about questionable decontamination operations, the MOE immediately established the headquarters for proper decontamination promotion to investigate the questionable cases. At the same time, the Ministry compiled the "appropriate decontamination program" consisting of three items: (1) enhancing established work responsibilities of business operators through unannounced inspections; (2) building a wide range of management systems by using effective monitoring by a third party; and (3) using the MOE organization effectively such as designating a telephone hotline to accept reports regarding questionable decontamination operations. Through these measures, the MOE tried to eliminate questionable decontamination operations and recover the confidence of residents.

Furthermore, based on the knowledge to the date, the MOE formulated the second edition of the Waste Guidelines in March 2013 and the second edition of the Decontamination Guidelines in May 2014. In April 2013, the MHLW formulated the "Guidelines to Prevent Radiation Hazards of Workers Engaged in the Disposal of Radioactive Materials Discharged by the Accident. Thus various guidelines were revised or expanded based on the experiences of decontamination progress.

In addition, with accumulation of good practices, in May 2013, the Fukushima Environmental Restoration Office compiled the "Examples of Good Practices in Decontamination" and distributed its copies to the decontamination business operators. This booklet introduced two categories of good practices with seven examples each: one category is technical good practices such as survey measurement technologies, decontamination technologies and decontamination operation management technologies, and the other category is communication good practices with the residents including the promotion of understanding and risk communication (See Figure 1-10 for examples).

On June 29, 2013, the full-scale decontamination operations that were the first full-scale project in the Special Decontamination Area were completed in Tamura City.

**Example 1 of the approach: Measurement of the spatial dose rate in high places such as roof and rain gutters**

**(Fukushima City, Koori Town)**

**[Challenge]**

**The grasp of the accurate pollution status of target facilities is necessary to promote the decontamination efficiently and to control its quality. In addition, the simplified measurement technique such as without footings is required when the measurement of the spatial dose rate in high places such as roof and rain gutters is required.**

**[approach]**

**By attaching a radiation measurement device to the tip of the long things such as extension pole or wash-line pole, it was done that the measurement personnel could measure the spatial dose rate in high places from the ground. With this method, it can be made easily to measure the spatial dose rate in high places.**

**Example 1) Example of Fukushima City:**
**With attaching the sensor of the NaI scintillation counter to the tip of the wash-line pole, air dose rates in the vicinity of a height of approximately 3m can be measured from the ground.**

**Example 2) Example of Koori Town:**
**With attaching a small video camera, a small radiation dose measuring instrument and communication a small radiation dose measuring device to the tip of the pole, the system which can receive the picture of the video camera with a monitor at hand was built.**
**By photographing together the measurement instrument display screen and the surrounding landscape with the video camera, pollution and radiation dose of the corresponding location can be confirmed on the ground monitor (tablet screen).**

**[Reference photograph]**
**Example 2) Example of Koori-Town:**
**◯Measurement scenery**


Figure 1-10 A good practice: Measurement of air dose rates in high places such as rooves and rain gutters[43].

[43]Source: Fukushima Environmental Restoration Office of the Ministry of the Environment "Good practices of decontamination " (May 2013)

## (8) Comprehensive review of the decontamination progress and review of the decontamination implementation plans in the Special Decontamination Area

In September 2013, the MOE announced the "Comprehensive Review of the Decontamination Progress." The review indicated the variations in progress among municipalities, because of the time required for reaching agreement with residents and securing temporary storage sites, and also the weather conditions such as winter snowfalls (Figure 1-11).

In particular, it was difficult to secure the sites for temporary storage and to acquire the consent for decontamination. Some residents were angry to have their area be selected as temporary storage for the wastes that they were not responsible for. Some feared that the temporary storage site ultimately would become the final disposal site without due consultation. Some feared the accumulation of contaminated soil. Some had different opinions about how to operate the decontamination. In all cases, because of the basic policy to fully respect the will and consent of residents before proceeding with the decontamination, there was no way but to build a trusting relationship and improve the understanding about temporary storage and decontamination. In this regard, not only the national and the local governments, but also the decontamination business operators and each worker made strenuous and consistent efforts.

・Since the situations of decontamination were different in each municipality, there was the variation in the progress of decontamination among municipalities. The importance of dealing with future issues based on the experience until now and promoting the decontamination in connection with the progress of restoration was enhanced. indicated the variation in progress among municipalities,
・The original target schedule was revised to allow a flexible decontamination schedule in accordance with the situation of each municipality after consulting with local inhabitants.

**Review of the current situations**

**Since the situations of decontamination were different in each municipality as described below, there was the variation in the progress of decontamination among municipalities.**

**Cases which needed the time for adjustment before starting decontamination are as follows;**
- **Review of the decontamination areas, development of the decontamination plan**
- **Securing the site for temporary storage, Obtaining informed consent for decontamination**
- **Corresponding to the concern about the influence on health of radiation and the effect of the decontamination**
- **Corresponding to the worry about that a transfer destination of the removed soil is not clear, because a plan for the establishment of interim storage installation isn't fixed.**

**Cases which needed the time for the conditions of the decontamination site are as follows;**
- **Natural influence such as snowfall**
- **Addition of compensation duties**
- **Development of the work procedures and the decontamination schedule in accordance with the situation of each municipality and progress of restoration.**

**Future challenges based on experience**
- **Ensuring of workers (labor-intensive decontamination work)**
- **Enhancement of safety measures (beginner for many workers)**
- **Load to traffic and waste disposal treatment (movement of the workers and transportation of the removed soil, processing of waste generated from the worker lodgings)**

**Coordination with the situation of restoration**
- **Facilitation of coordination between the decontamination work and restoration projects (infrastructure preparation, restoration base servicing, changeover of land use, etc.)**
- **Review of the decontamination implementation plan based on the returnees expected timing**
- **Review of the decontamination implementation plan taking into account the differentiation of the indication of residents' will on their intention of return and the time,**

**Future direction**
- **Revise the original target schedule, which would complete the decontamination and transfer the waste and soils to temporary storage without exception within two years, and promote the decontamination schedule in accordance with the situation of each municipality and progress of restoration.**
- **In that case, in addition to taking appropriate measures for acceleration and facilitation of decontamination, reconsider the original schedule of the decontamination flexibly in accordance with the situation of each municipality and progress of restoration.**
- **In Tamura City, measures of the decontamination and related works based on the decontamination plan were completed. In Naraha Town, Kawauchi Village and Okuma Town , completion of the decontamination will be aimed at by the end of fiscal year 2013 according to the current decontamination plan. In Minamisoma City, Iitate Village , Kawamata Town , Katsurao Village , Namie Town and Tomioka Town , the present decontamination plan is continued to be adjusted with each municipality, and will be changed by the end of the year. In Futaba Town, the adjustment is continued to be performed with the municipality towards the development of the decontamination plan in connection with the consideration of the progress of restoration**

Figure 1-11 Review results of the current decontamination plans, etc. in the Special Decontamination Area[44].

[44] Source: Ministry of the Environment (MOE), "Overall review of the progress of decontamination"

Therefore, the original target schedule, which would "complete the decontamination and transfer the waste and soil to temporary storage sites in all cases within two years," was revised to allow a flexible decontamination schedule in accordance with the situation of each municipality and progress of restoration. Then where the progress differed by municipalities, the plans were revised to better fit with the actual situation. Also reviewed was the conventional way of forest decontamination that had been previously conducted in a range of about 20 meters from the forest edge. In the revision, for the forest surrounding the residential areas in valleys with high dose rates as shown in Figure 1-12, if the dose rates in the area surrounding the residential area was still relatively high after area-wide decontamination, effective decontamination exceeding the 20-meter range from the forest edge was allowed on an exceptional basis.

In the meantime, the Forestry Agency, working from the viewpoint of forestry regeneration, has implemented a demonstration project to integrally promote the forest maintenance and measures against radioactive materials. As a demonstration project, in forests in the Intensive Contamination Survey Area, forest maintenance practices such as thinning were mainly operated by public entities of the prefecture and municipalities. Also, through conducting the disposal and reducing the amounts of foliage generated from forest maintenance, and through creating wood fences to control the diffusion of radioactive materials, the Forestry Agency has conducted efforts to collect knowledge necessary for the smooth maintenance of forests in the areas affected by radioactive materials.

In December 2013, the review of each decontamination implementation plan based on the comprehensive review was conducted and the "Review of the Decontamination Implementation Plans in the Special Decontamination Area" was announced.

| |
|---|
| **Area A (forest surrounding the residential areas)** |
| ·If the effect of decontamination with the removal of the deposited organic matter such as fallen leaves, can not be obtained, it is permitted to remove the residue of accumulated organic matter additionally in a range of 5-meter from the forest edge as a rough indication (as the outflow of sediment is concerned, preventive measures against it such as the setting of the sandbag must be appropriately carried out depending on the situation in the field).<br>·For the forests surrounding the residential areas in valleys with high dose rates , effective decontamination work beyond 20-meters from the forest edge may be exceptionally continued on the case-by-case basis, if the dose in the area surrounding the residential area was still relatively high after the ongoing decontamination work is finished over relatively wide areas. |
| **Area B (Forest users and workers enter on a daily basis)** |
| ·For bed log laying yard, if the continuation and restarting of cultivation are expected, it is permitted to remove the accumulated organic matter, such as fallen leaves, in the cultivated land and in the area in the reach of about 20m of its surrounding, according to the decontamination method of forest in area A, |
| **Area C (forest except area A and B)** |
| ·The Ministry of Environment takes a new approach based on the indications concerning the possible outflow of radioactive materials to the living area from the area where understory vegetation is decline partially weathering.<br>·In the Forestry Agency, a demonstration project is advanced from the point of view of forest regeneration to the decontamination of the forest where it is located outside of the living area and forestry was carried out, while dealing with radioactive materials. |

Figure 1-12 Future direction of decontamination works in forests[45].

In the meantime, the policy for rivers and lakes was also announced. Previously, due to the shielding effect of water, the existence of inflow sediment from the land, and the movement within the watersheds, it was planned to study measures after accumulating investigation results and research while conducting regular monitoring. In August 2014, the MOE announced the "summary of concept in the future measures for rivers and lakes". It stated that "the decontamination should be made as needed in the living zones with many public activities and with high dose rate due to accumulation of radioactive cesium, when water is dried up and no shielding effect is expected".

In October 2013, when the "Comprehensive review results of the progress of decontamination" was announced, as a follow-up to the IAEA international mission two years earlier, the IAEA follow-up mission team visited to confirm the progress of the situation and to compile recommendations as given below.

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(September 2013)

[45]Source: Forestry Agency: "Forest /forestry white paper in fiscal year 2013" (May 30, 2014)

- Examples of thirteen highlights of important progress and recommendations on eight points which were shown in the "Final Report: The Follow-up IAEA International Mission on Remediation of Large Contaminated Areas Off-Site the Fukushima Daiichi Nuclear Power Plant"[46,47]

【Examples of thirteen highlights of important progress】

- The Team acknowledges the institutional arrangements implemented by Japan to address the remediation needs of the areas affected by TEPCO's Fukushima Daiichi NPP accident. The Team appreciates that Japan makes enormous efforts to implement the remediation programme in order to reduce exposures to people in the affected areas, to enable, stimulate and support the return of people evacuated after the accident, and to support the affected municipalities in overcoming economic and social disruptions. The review Team recognizes the involvement of a wide range of ministries and agencies, as well as institutions of the municipalities, to support remediation by providing financial resources, technical guidance and institutional assistance.
- The Team welcomes the critical evaluation of the efficiency of the removal of contaminated material compared with the reduction in dose rate offered by different methods of decontamination, recognizing that this is an important tool in the application of decontamination methods. In addition, the Team notes a welcome change from guiding remediation efforts based on surface contamination reduction, to a reduction in air dose rates. This is leading some municipalities to conclude that an additional 1 mSv per year is more applicable to long-term dose reduction goals.
- The Mission Team found significant progress in the development and implementation of temporary storage facilities by municipalities and the National Government for contaminated materials generated by on-going remediation activities. In addition, the Mission Team notes the progress made towards the establishment of interim storage facilities by the National Government with the cooperation of municipalities and local communities.

【Examples of recommendations on eight points】

- Japanese institutions are encouraged to increase efforts to communicate that in remediation situations, any level of individual radiation dose in the range of 1 to 20 mSv per year is acceptable and in line with the international standards and with the recommendations from the relevant international organisations, e.g. ICRP, IAEA, UNSCEAR and WHO. The appropriate application of the optimisation principle in a remediation strategy, and its practical implementation, requires a balance of all factors that influence the situation, with the aim of obtaining the maximum benefit for the health and safety of the people affected. These facts have to be considered in communication with the public, in order to achieve a more realistic perception of radiation and related risks among the population. The Government should strengthen its efforts to explain to the public that an additional individual dose of 1 mSv per year is a long-term goal, and that it cannot be achieved in a short time, e.g. solely by decontamination work. A step-by-step approach should be taken towards achieving this long-term goal. The benefits of this strategy, which would allow resources to be reallocated to the recovery of essential infrastructure to enhance living conditions, should be carefully communicated to the public. The IAEA – and very likely also the international scientific community – is ready to support Japan in this challenging task.

## (9) The start of lifting of evacuation orders associated with the completion of full-scale decontamination and other progresses, and follow-up decontamination

In April 2014, after the completion of full-scale decontamination in June 2013, the evacuation order was lifted on the Special Decontamination Area in Tamura City. On the other hand, in July 2014, the decontamination implementation plan was finally formulated in Futaba Town, where the formulation had been delayed the longest. As a result, formulations

[46]Source: IAEA "Final Report: The Follow-up IAEA International Mission on Remediation of Large Contaminated Areas Off-Site the Fukushima Daiichi Nuclear Power Plant" (January 23, 2014) （http://www.env.go.jp/press/file_view.php?serial=23734&hou_id=17656）

[47]Source: Excerpt from the draft translation (summary portion only) of the IAEA "Final Report: The Follow-up IAEA International Mission on Remediation of Large Contaminated Areas Off-Site the Fukushima Daiichi Nuclear Power Plant " (January 23, 2014)

of the decontamination plans in all municipalities in the Special Decontamination Area were completed (except areas where it was expected that residents will face difficulties in returning for a long time), and decontamination and measures toward the lifting of the evacuation order have been implemented.

The effects of the decontamination operations are reviewed by the post-monitoring to be conducted at six to twelve months after the initial decontamination operations. If there are places with erosion of effectiveness of decontamination, the investigation will be conducted to identify the cause as much as possible according to the individual situation. Then, by judging the rationality and feasibility, the follow-up decontamination operations will be implemented[48].

### 1.1.3. Overview of the change of the evacuation area designation

As mentioned in 1.1.2, the designation of the evacuation areas was changed several times (Figure 1-13). The outline of each evacuation area and the background to the modification of the designated areas are indicated here.

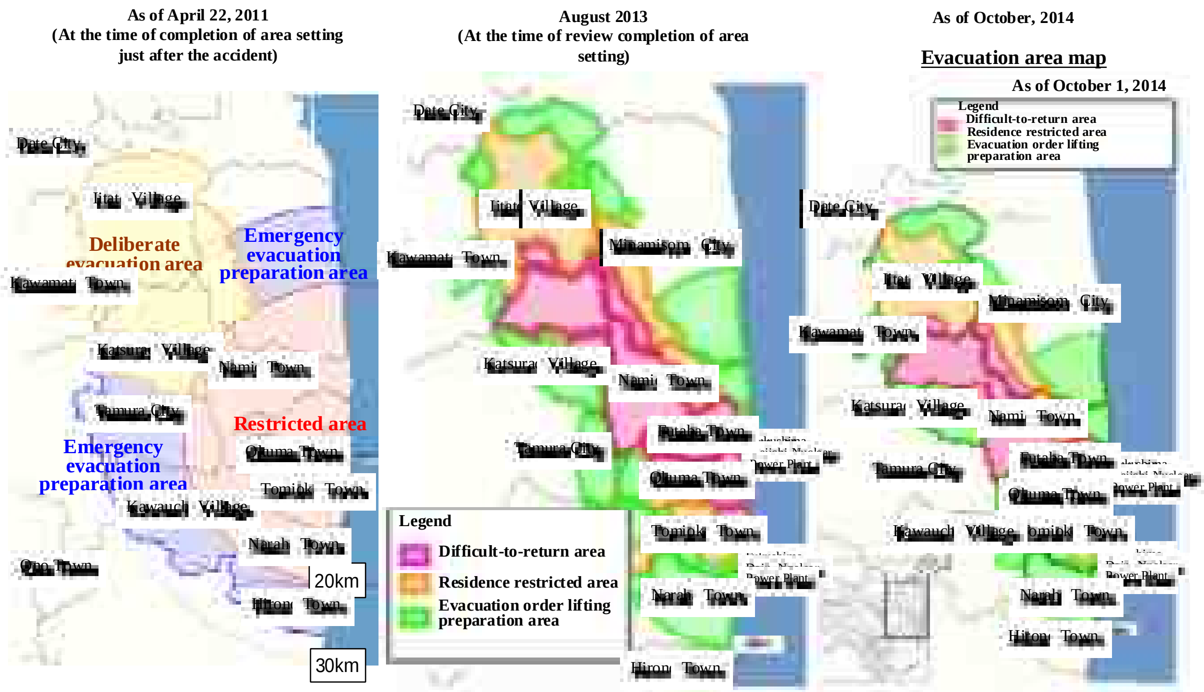


Figure 1-13 Change of the evacuation areas[49].

### (1) Setting of the evacuation area and indoor evacuation area

In order to ensure the health and safety of the residents in the region around the FNPS, based on the situation of the reactors, the NERH directed the Fukushima Governor and the Mayors of other relevant municipalities to instruct their residents to evacuate or to shelter indoors, based on the "Act on Special Measures Concerning Nuclear Emergency Preparedness" (hereinafter referred to as the Nuclear Emergency Preparedness Act). (The directions on sheltering were lifted on April 22, 2011.)

[48] Source: The 11th Environmental Remediation Study Meeting Material: Follow-up decontamination (March 20, 2014)

[49] Source: Ministry of Environment (MOE), Evacuation area maps created based on the document of the "Government Nuclear Disaster Victims Life Support Team"

It should be noted that for the TEPCO's 2FNPS the risk of a serious accident occurrence decreased to a considerable degree in comparison with the situation on March 12, 2011 when the nuclear emergency had been declared. Therefore, the evacuation area which had been set as the area within the radius of 10 km from the 2FNPS was changed to the area within the radius of 8 km on April 21, 2011.

### （2） Setting of the restricted area, deliberate evacuation area, and emergency evacuation preparation area

In order to ensure smooth evacuation of residents step-by-step, besides the restricted area and deliberate evacuation area, an emergency evacuation preparation area was set to deal with any future emergency.

#### 1）Restricted area

In order to ensure the safety of the residents, the NERH announced to the Fukushima Governor and the Mayors of other relevant municipalities that it set the area within the radius of 20 km from TEPCO's 1FNPS as the restricted area based on the Nuclear Emergency Act (April 21, 2011). According to this instruction, nobody, except those who were engaged in the emergency response measures, including such public officials as firefighters, police officers, maritime officers, and self-defense force personnel, has an access to the area without the permission of the mayors after 00:00 on April 22, 2011.

#### 2）Deliberate evacuation area

The NERH set the areas where the cumulative dose during the period of one year after the 1FNPS accident might reach 20 mSv as the "deliberate evacuation area," where evacuation to outside the area was required for residents within roughly 1 month, in consideration of the impact on their health (April 22, 2011).

#### 3）Emergency evacuation preparation area

The NREH lifted the direction of indoor evacuation in the area within the radius of 20 km and 30 km from TEPCO's 1FNPS. On the other hand, under the accident situation which has not yet been stabilized, there were some areas where the need for such refuge could not be excluded in an emergency. The NERH designated such areas as the "emergency evacuation preparation area," where the residents are required to prepare for being able to evacuate indoors or to take refuge in an emergency (April 22, 2011).

### （3） Rezoning through lifting and reviewing of former designations

The NERH announced the concept for the review of the evacuation area. The announcement stated the evacuation orders had substantial impact on the lives of residents and it would be appropriate to review the evacuation orders, once a significant change occurred in the situation, for example, the verification of safety of nuclear reactor facilities was made or the reduction of dose was confirmed on the basis of continued monitoring. It was decided that the evacuation area would be reviewed, revised and set as the new evacuation designated areas according to their perspectives of recovery and reconstruction, based on the results of radiation monitoring and the safety evaluation of the reactors and other factors,.

#### 1）Lifting of the designation of emergency evacuation preparation area

Concerning the emergency evacuation-preparation area, which the NERH had designated between the radius of 20 km and 30 km from 1FNPS as the area where emergency responses such as evacuation might be requested in an emergency, the NERH decided the policy[50] (August 9, 2011) when to lift the designation The policy dictated that the designation should be lifted when the following conditions become foreseeable; safety evaluation of the nuclear power station, radiation monitoring results in detail in the area, and restoration of public services and infrastructures in the area.

Based on this policy, the relevant municipalities started the development of their own “recovery plans” according to their respective circumstances, in which the intentions of the residents were sufficiently reflected and cooperation with the prefecture was taken into account. Each plan included support of the residents’ smooth resettlement, reopening of public services such as schools and medical facilities, restoration of public infrastructure, and, decontamination of school grounds and parks. At the stage when the development of the individual plans was completed, the NERH decided to lift the designation of the emergency evacuation preparation area collectively and notified the relevant municipalities (September 30, 2011).

### 2）Reviewing of restricted area and evacuation area

Based on the recognition of termination of the accident at TEPCO’s 1FNPS and the reduction in the risk of radiation exposure, the NERH decided a policy to lift the designation of the restricted areas (the areas within the radius of 20 km from the nuclear power station) progressively, after making safety checks and completing the emergency restoration of infrastructures, and also after coordinating among the persons concerned for disaster prevention and crime prevention measures, etc. In addition, for the evacuation areas (the restricted areas within the radius of 20 km, and the deliberate evacuation areas located beyond the radius of 20 km from the nuclear power station), it was decided to review those areas and to classify them into three new areas cited below as shown in Figure 1-14, based on the radiation dose rates in those areas, and after having discussions with the persons concerned (December 26, 2011). It is noted that the various kinds of limitations were mitigated especially in the areas in which evacuation orders are being prepared for lifting (the evacuation order lifting preparation area) as shown in Table 1-2.

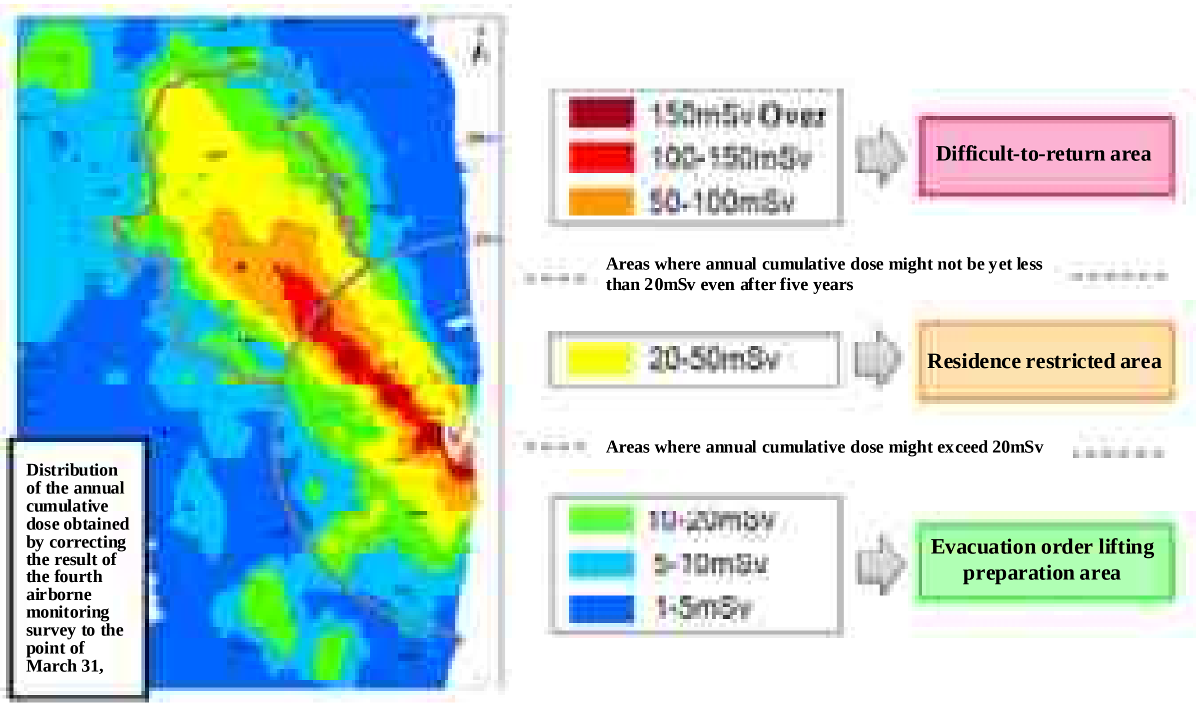


**Figure 1-14 Review of the categories of evacuation areas into three designated areas based on the annual cumulative dose estimated from air dose[51].**

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[50]Source: Nuclear Emergency Response Headquarters (NERH), "The basic concept on the review of evacuation areas" (August 9, 2011)

[51]Source: Cabinet Office, "Review of the Evacuation Area" (October 2013) (Table 1-2 also the same source)

- Areas in which evacuation orders are being prepared for lifting (hereinafter referred to "Evacuation order lifting preparation area")

The evacuation order lifting preparation area refers to the area where it was confirmed that the annual cumulative dose would not exceed 20 mSv in the evacuation areas as of December 26, 2011. In those areas, the evacuation orders are still continued, but the supporting measures for recovery and reconstruction, such as decontamination, infrastructure restoration, employment promotion, should be taken quickly, and residents' return as soon as possible should be the aim.

It is noted that the evacuation orders will be lifted based on sufficient consultations with authorities of the prefecture and municipalities, and residents, under the condition that the infrastructures indispensable to daily life are almost restored, such as electricity, gas, water and sewerage systems, main transportation networks, and postal and communication services, and the life-related services including medical and nursing care, and at the stage in which the decontamination works mainly for the living environment of children are progressed sufficiently.

When lifting the evacuation order, the circumstances of each municipality have to be considered sufficiently. Therefore, the evacuation order should be lifted, not simultaneously in the whole area, but when each relevant municipality considers individually most appropriate. It can be also lifted step-by-step even within one municipality.

- Areas in which residents are not permitted to reside (hereinafter referred to as the "Residence restricted area")

The residence restricted area refers to the areas where the annual cumulative dose might exceed 20 mSv among the evacuation areas as of December 26, 2011, and that subsequently require continued refuge from the viewpoint of reducing the dose of the residents. In those areas, decontamination works and infrastructure restoration, etc. are carried out premeditatedly, aiming at the residents' return and reconstructing of the community in the future.

In addition, it has been decided to shift those areas to the "evacuation order lifting preparation area," when it is confirmed that the annual cumulative dose that inhabitants receive will not exceed for sure 20 mSv due to the decontamination works and the natural decay of radioactive materials.

- Areas where it is expected that the residents have difficulties in returning for a long time (hereinafter referred to as the "Difficult-to-return area")

The difficult-to-return area refers to the areas among the evacuation areas where the annual cumulative dose might not be yet less than 20 mSv even after five years, and exceeds 50 mSv as of December 26, 2011. According to the principle that the residence would be restricted in those areas for the future, it was decided that the designation of those areas would not be reviewed for five years. However, even in that case, according to contamination level due to radioactive materials in the future, the contents of the planning for reconstruction and restoration in related municipalities and the situation of their implementation, it was decided that the implementation of the review of those measures be considered.

It should be noted that the evacuation areas were reviewed and classified into three new designated areas using air dose rates basically as mentioned above. However, the distribution of air dose rates is complicated and is not uniform. Therefore, it was considered to be a basic principle from a practical viewpoint to avoid division of a community and to set the whole of the administrative section unit as one area within the newly classified areas, based on the dose level which occurs in most places within the administrative section unit.

Review of the evacuation areas was performed through coordination with the relevant local municipalities and residents. The designation of the area classification is closely related to the timing of return and the compensation. Therefore, there were some areas that needed much time for the adjustment. As a result, it was not until August 2013 that the review of all evacuation areas was completed.

## Table 1-2 Mitigation of the limits due to the review of the evacuation areas

| | | | Before review | After review: Difficult-to-return area | After review: Residence restricted area | After review: Evacuation order lifting preparation area | Change before and after the review of areas |
|---|---|---|---|---|---|---|---|
| Area control | | Access to area | △ ＊Accessible in deliberate evacuation area | × | ○ | ○ | Accessible to home, etc. (excluding the difficult-to-return areas) (Notes 1) |
| Area control | | Staying at home, etc. | × | × | × | × | — |
| Area control | | Special staying | × | × | ○ | ○ | Allowed to stay at home during certain time-period(Notes 2) |
| Area control | | "Staying for the preparations for the return to hometown" | × | × | △ (Notes3) | ○ | Permitted long-term staying if certain requirements are met. |
| Area control | | Starting of new companies and business activities (company invitations, etc.) | × | × | △ (Notes4) | ○ (Notes5) | Allowed to invite new companies |
| Area control | | Reoperation of existing companies and businesses | × | × | △ (Notes4) | ○ (Notes5) | Permitted reoperation of the existing businesses |
| Area control | | Farming/Forestry | × | × | × (Notes6) | ○ (Notes6) | Permitted restarting in a part of the evacuation areas |
| Reconstruction restoration businesses | Budget | Living environment improvement businesses | × | ○ (Notes7) | ○ (Notes7) | ○ | Acceleration of reconstruction and restoration businesses |
| Reconstruction restoration businesses | Budget | Return and restoration acceleration business | — | ○ | ○ | ○ | |
| Reconstruction restoration businesses | Tax (for businesses) | Special depreciation, etc., or tax credits to capital investment | × | × | ○ | ○ | Realization of the treated well business environment (except for return difficult areas) |
| Reconstruction restoration businesses | Tax (for businesses) | Tax credit for salaries to employees | × | × | ○ | ○ | |

(Note 1) Allowed temporary access to the residence restricted areas and evacuation order lifting preparation areas within the extent that municipalities recognize this. A year-round open system (temporary access to those areas once every month (Except for January and April) on the day when inhabitants hope) is being conducted in Okuma Town, Tomioka Town, Namie Town and Futaba Town.

(Note 2) It is possible to stay overnight during a certain period of time, based on application to authorities of the municipalities and after the confirmation of the nuclear disaster site headquarters. The total number of residents to stay overnight was 1,870 in New Year, Golden Week and Spring and Autumn Equinox Festivals (implemented municipalities: Kawauchi Village, Tamura City, Minami-soma City, Iitate Village, Katsurao Village and Kawamata Town).

(Note 3) In principle, the long-term staying applies to the evacuation order lifting preparation areas. Even in residence restricted areas, if the requirements are met, on the basis of consultation with the chiefs of municipalities and the head of nuclear disaster site response headquarters, long-term staying is permitted.

(Note 4) For the businesses that are indispensable in the restoration and reconstruction and recognized exceptionally, and the businesses that are not intended for residents (financial institutions, waste disposal treatment facilities, gas stations, manufacturing industries, etc.), it is possible to start the business operations after passing through the predetermined procedures.

(Note 5) As a general rule, the starting of the business to target the residents is impossible. However, for hospitals, welfare nursing facilities, restaurant businesses, retail trade and services, etc., the starting of the preparation works for implementation of businesses such as new construction and repair of facilities, receiving of materials and equipment, and inventory control, is possible.

(Note 6) Farming in the evacuation order lifting preparation area can be restarted based on the planting restrictions of rice and the status of decontamination. On the other hand, in the residence restricted areas, it is possible to carry out the maintenance and management of agricultural lands. It is also possible to carry out the planting demonstration projects etc., aiming at restart of farming in those areas, which are performed under the participation of public organizations of municipalities.

(Note 7) Living environment improvement businesses are limited only if those are deemed necessary for reconstruction and restoration toward the designation of the evacuation order lifting preparation area.

### 1.1.4. Outline of the Act on Special Measures Concerning the Handling of Environmental Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District-Off the Pacific Ocean Earthquake that Occurred on March 11, 2011

（1） **Act on Special Measures**

1）The point of the Act on Special Measures

This Act was established to address the urgent issue of reducing promptly the impact of environmental contamination on human health and the living environment caused by radioactive materials, which had been released by the nuclear power plant accident associated with the Great East Japan Earthquake. It defines that the basic principles regarding the handling of the environment pollution caused by radioactive materials are determined in a cabinet meeting, and that the monitoring and measurement are carried out to determine the status of the environmental contamination by accident-derived radioactive materials. It also sets the matters relating to the disposal of wastes and the matters on measures for decontamination of soil, etc. contaminated by radioactive materials.

2）The Basic Principles under the Act

The Basic Principles under the Act provide a decontamination framework and were approved in the Cabinet meeting on November 11, 2011.

The following goals have been established in the Basic Principles.

- The areas where the annual additional exposure dose exceeds 20 mSv are aimed to be reduced in size step-by-step but as quickly as possible. However, it is necessary to note that a long-term approach is required for the areas where the radiation exposure dose is particularly high.
  The specific decontamination goals in these areas shall be set in the future based on the effect of decontamination measures of soil and wastes, the results of demonstration model projects and other development.
- For the areas where the annual additional exposure dose is below 20 mSv, the following goals are set.
  - ✓ The annual additional exposure dose decreases to 1 mSv/y or less in the long-term.
  - ✓ The annual additional exposure dose of the general public is reduced by about 50% by the end of August 2013 as compared with that at the end of August 2011, by including physical attenuation of radioactive materials and other factors..
  - ✓ It is important to restore the environment where children can live without fear. Therefore, the goal is set to reduce the annual additional exposure dose of children by about 60% by the end of August 2013 as compared with that at the end of August 2011, by decontaminating their living environment such as schools and parks in high priority and including physical attenuation of radioactive materials..

These goals will be reviewed appropriately based on the effects of measures of the decontamination of soil, etc.

In addition, for the Special Decontamination Area excluding the areas with particularly high additional exposure dose, the schedule to complete the decontamination in those areas in approximately two years was shown; “by the end of March 2014, measures for the decontamination of soil, etc., are carried out in residences, offices, buildings of public facilities, roads, farmlands, forests around the living space, etc., and soil removed by decontamination works is conveyed to the properly managed temporary storage sites one after another”.

Further, for the areas with particularly high additional exposure dose, it was indicated that the National Government should implement demonstration model projects first.

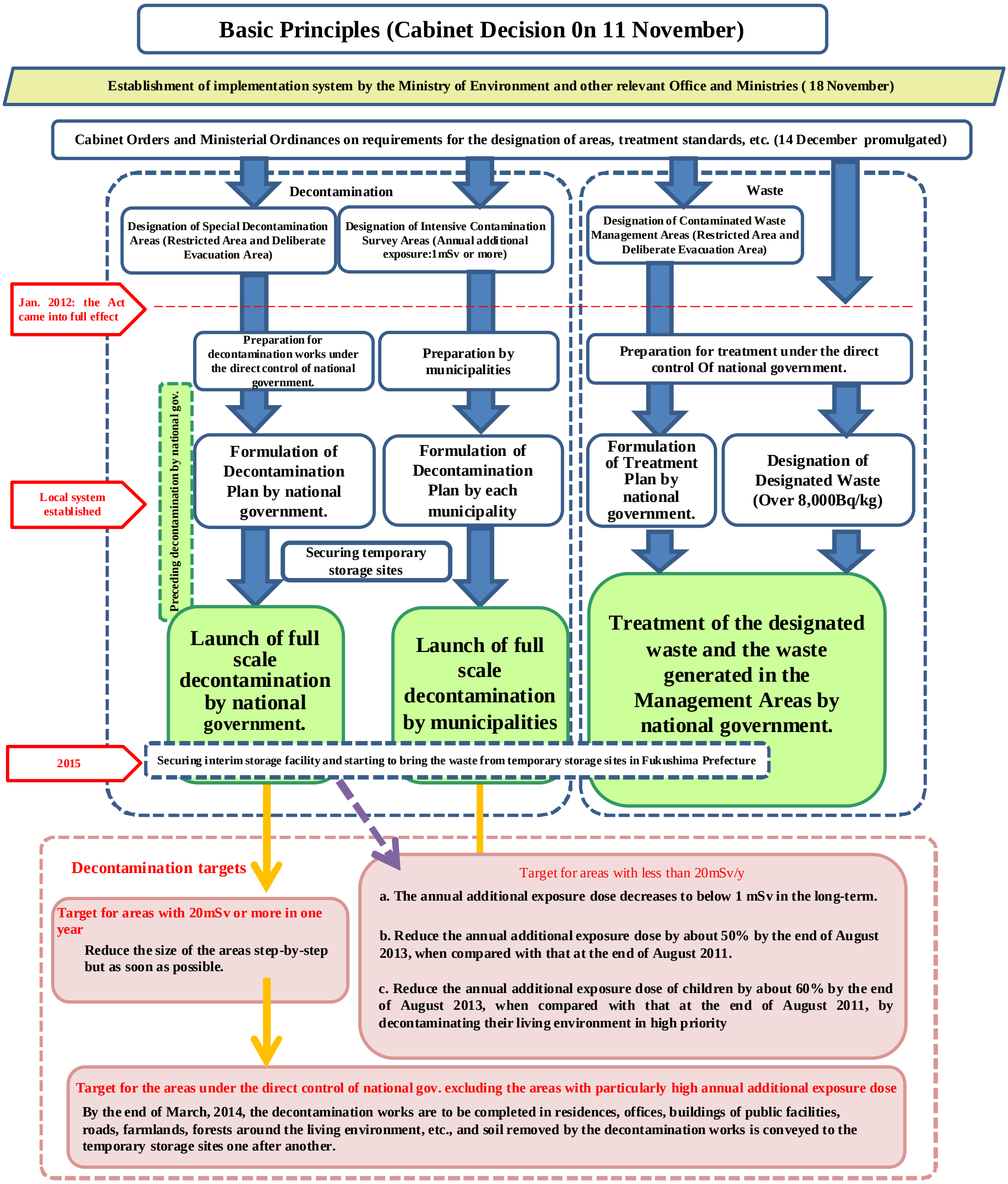



Figure 1-15 Outline of the Implementation of the Act on Special Measures[52].

## （2） Urgent implementation basic policy on decontamination

As indicated in 1.1.2.(4) 1), prior to the promulgation of the Act on Special Measures, the "Urgent Implementation Basic Policy on Decontamination" was announced on August 26, 2011 by the NERH. In it, the following five items were defined as the provisional targets in implementing the decontamination.

52 Document of Ministry of the Environment

(i) Based on the 2007 basic recommendations of the International Commission on Radiological Protection (ICRP) and the “basic concept” of the Japanese Nuclear Safety Commission, the areas with the situation of emergency radiation exposure (the annual additional exposure dose exceeds currently 20 mSv) are aimed to be reduced in size step-by-step but as quickly as possible.

(ii) For the areas with the situation of existig exposure (the areas where the annual additional exposure dose is 20 mSv/y or less), the aim is to reduce the annual additional exposure dose to 1 mSv/y or less in the long term.

(iii) As a specific target of decontamination implementation in the areas contaminated by radioactive materials, it is aimed that the estimated annual exposure dose of the general public be reduced by about 50% in two years.
According to the NERH provisional estimates, the estimated annual exposure dose after two years will be reduced by about 40% compared with the estimated annual exposure dose at present, by physical attenuation of radioactive materials and by natural factors such as wind and rain (weathering effect).
By reducing at least approximately 10% of the exposure dose by decontamination works, the above target of 50% reduction of the exposure dose will be achieved. In addition, further reduction of exposure dose will be pursued.

(iv) It is important restore the environment where children who are more susceptible to radiation than adults can live in peace as before. Thus, it is aimed that the estimated annual exposure dose of children be reduced by about 60% in two years through thorough decontamination works in their living environment such as schools and parks.
According to the NERH provisional estimates, the estimated annual exposure dose of children after two years will be reduced by about 40% compared with the estimated annual exposure dose at present, by physical attenuation of radioactive materials and by natural factors such as wind and rain (weathering effect).
By reducing at least approximately 20% of the exposure dose by decontamination works, the above target of 60% reduction of the exposure dose will be achieved. In addition, further reduction of exposure dose will be pursued.

(v) The targets mentioned above are the provisional targets being set based on limited information in order to urgently implement the decontamination works. Those should be examined and reviewed on a timely basis through detailed monitoring and accumulation of data, survey of actual exposure dose of children, and decontamination demonstration model projects.

In addition, the "Urgent Implementation Basic Policy on Decontamination" mentioned that for the achievement of these provisional targets, the National Government would continuously provide technical information ("a technical catalogue") necessary for the decontamination works, including effective decontamination methods, costs, precautions to make, which would be obtained through the demonstration model projects and the approach how to proceed with decontamination of each area depending on the difference in dose. The following four points were mentioned as the methods for "treatment of soil, etc. produced by decontamination works".

(i) The treatment of soil generated as a result of decontamination works, and rice straw, compost and debris that exist in the region, are indispensable for the implementation of smooth and quick decontamination works.

(ii) For treating such soil and wastes, the National Government takes responsibility for securing of their disposal sites where long-term management is required, and ensuring their safety. The National Government would publish a road map for the construction as quickly as possible.

(iii) However, in order to take these fundamental measures, time for securing and development of disposal sites of a certain size will be required. If we wait until such disposal sites are ready, it might delay quick decontamination.
(iv) Therefore, it is realistic for the time being that soil and wastes generated as a result of decontamination works are stored in temporary storage sites in each municipality or community. The National Government should continue all possible efforts to support municipalities in financial and technical aspects.

The Basic Principles of the Act on Special Measures shown in 1.1.4 (1) 2), are intended to take over the "Urgent Implementation Basic Policy on Decontamination."

### （3） Prevention of radiation hazards due to decontamination works

The MHLW enforced the Ionizing Radiation Ordinance for Decontamination” on January 1, 2012, as a measure to reduce the radiation exposure dose of workers who were engaged in such works as decontamination works (hereinafter referred to as "decontamination workers").

Then, in July 1, 2012, the Ionizing Radiation Ordinance for Decontamination was revised to expand the applicable works in order to include the prevention of radiation hazards to the workers who were engaged in restoration/reconstruction and related works.

The main features of the Ionizing Radiation Ordinance for Decontamination are given below. The Ordinance is applied to the business operators for decontamination or works under a designated dose rate, their employees engaged in decontamination or works, under a designated dose rate.

(1) Basic principles of prevention of radiation hazards
(2) Limits and measurement of dose
(3) Measures concerning the implementation of decontamination and related works
(4) Prevention of contamination
(5) Special education, medical examinations, and others

Further, the MHLW developed the following two guidelines in order to enable business operators and their workers to perform decontamination related works in accordance with the Ionizing Radiation Ordinance for Decontamination.

- Guidelines for the prevention of radiation hazards of workers engaged in decontamination works, etc.
- Guidelines for the prevention of radiation hazards of workers engaged in works under a designated dose rate

These guidelines specify the items such as protection measures, medical examination offices and others.

## 1.1.5. Overview of the Special Decontamination Areas

### （1） Requirements and designated situations for the Special Decontamination Area

The Special Decontamination Area is specified according to the Act on Special Measures as the area where the decontamination plans are developed by the MOE and the decontamination work is conducted under the direct jurisdiction of the National Government. It basically corresponds to the areas that were the restricted area within the 20 km radius from the TEPCO 1FNPS and the areas that were the deliberate evacuation area where the cumulative exposure dose for one year after the accident might exceed 20 mSv.

Specifically, as shown in Figure 1-16, the whole area of Naraha Town, Tomioka Town, Okuma Town, Futaba Town, Namie Town, Katsurao Village and Iitate Village, and the areas that were restricted areas or deliberate evacuation areas in Tamura City, Minami-soma City, Kawamata Town, and Kawauchi Village correspond to the Special Decontamination Area.


Figure 1-16 Special Decontamination Area[53].

## (2) Structure of the decontamination works in the Special Decontamination Area

The decontamination for the Special Decontamination Area was scheduled based on the following basic policies. As shown in Figure 1-17, the decontamination implementation plans were developed at first by the Minister of the Environment. Preliminary decontamination for municipality offices and infrastructure facilities were conducted, while model projects were conducted by the Cabinet Office and the MOE, and then, full-scale decontamination is performed. As shown in Figure 1-18, the decontamination works have to be advanced while obtaining the landowners' consents because it is necessary to enter people's property to conduct full-scale decontamination

It is also necessary to secure temporary storage sites because a large amount of removed soil and contaminated wastes are generated as the decontamination works progress.

[53]Source: Ministry of the Environment (MOE), "Request for the cooperation for decontamination works" (February, 2012)

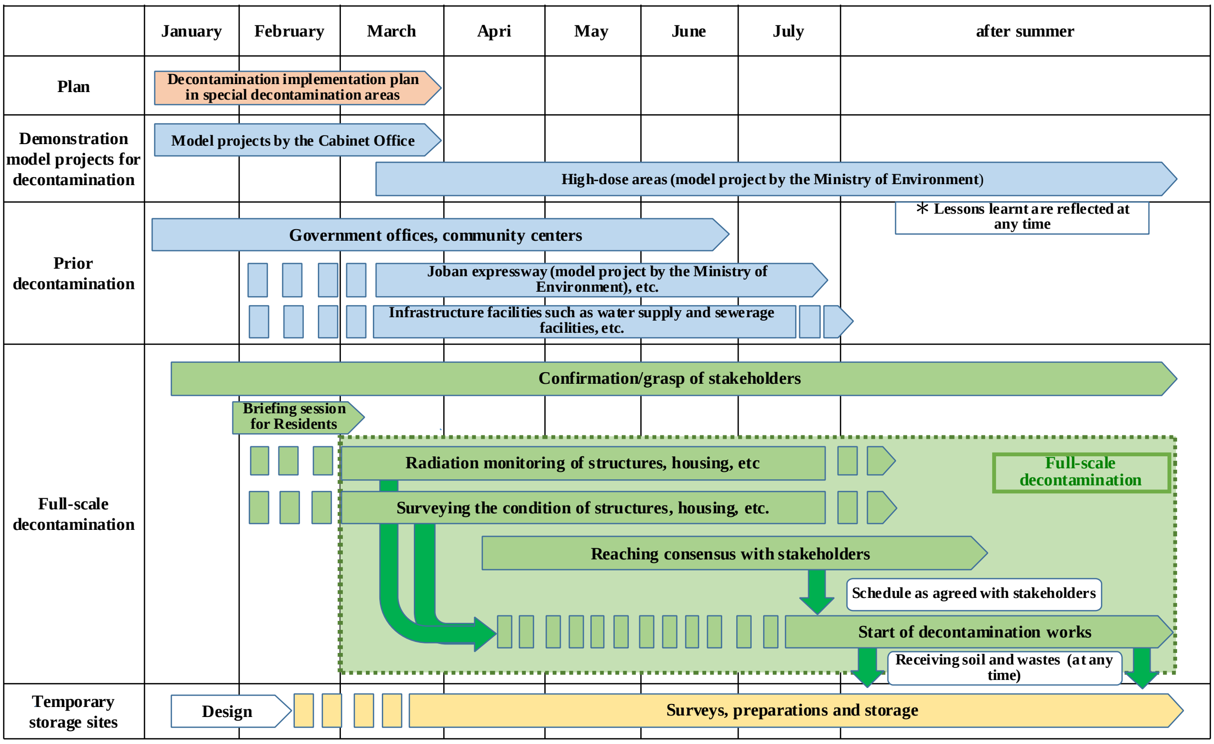



Figure 1-17 The short-term decontamination roadmap for Special Decontamination Area[54].

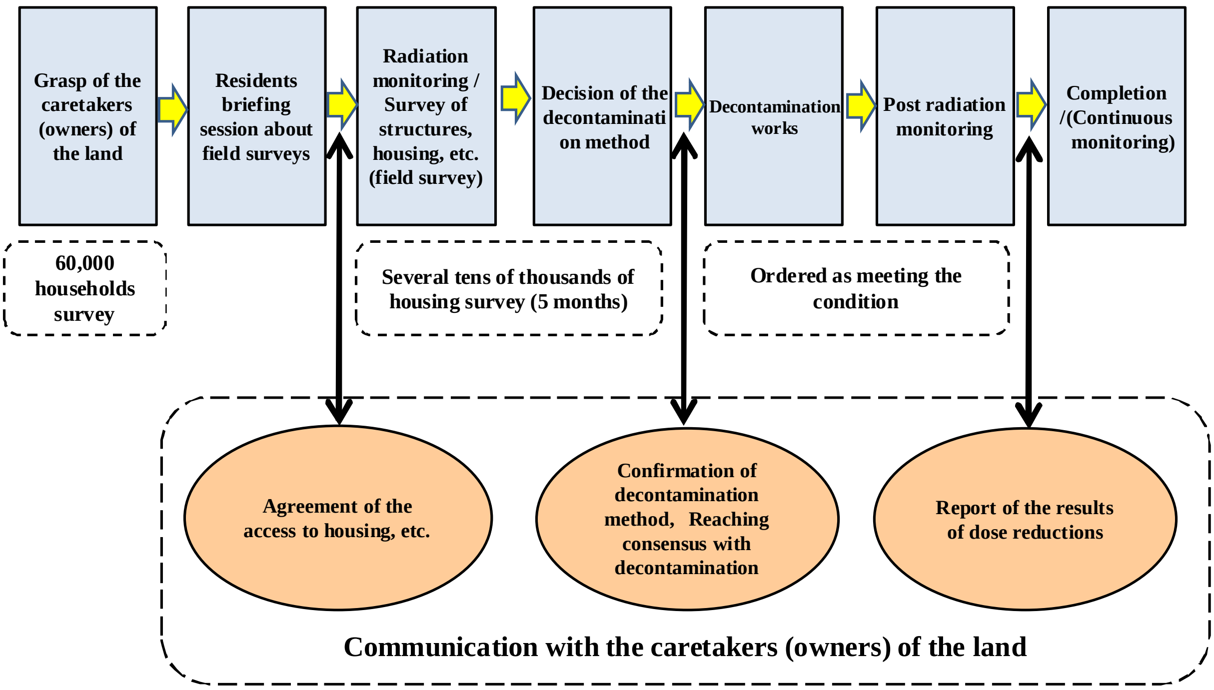



Figure 1-18 Flow chart of the decontamination steps.

[54]Source: Ministry of the Environment (MOE), "Decontamination Policy for Special Decontamination Areas (Decontamination Roadmap)" (January 26, 2012)(Figure 1-18 through Figure 1-20)

In addition, the Special Decontamination Area is classified into three areas depending on the level of exposure doses. Decontamination is due to start from the areas of the low exposure dose level, as shown in Figure 1-19, because the difficulty differs depending on radiation levels. The targets of decontamination in each area are as shown in Figure 1-20.

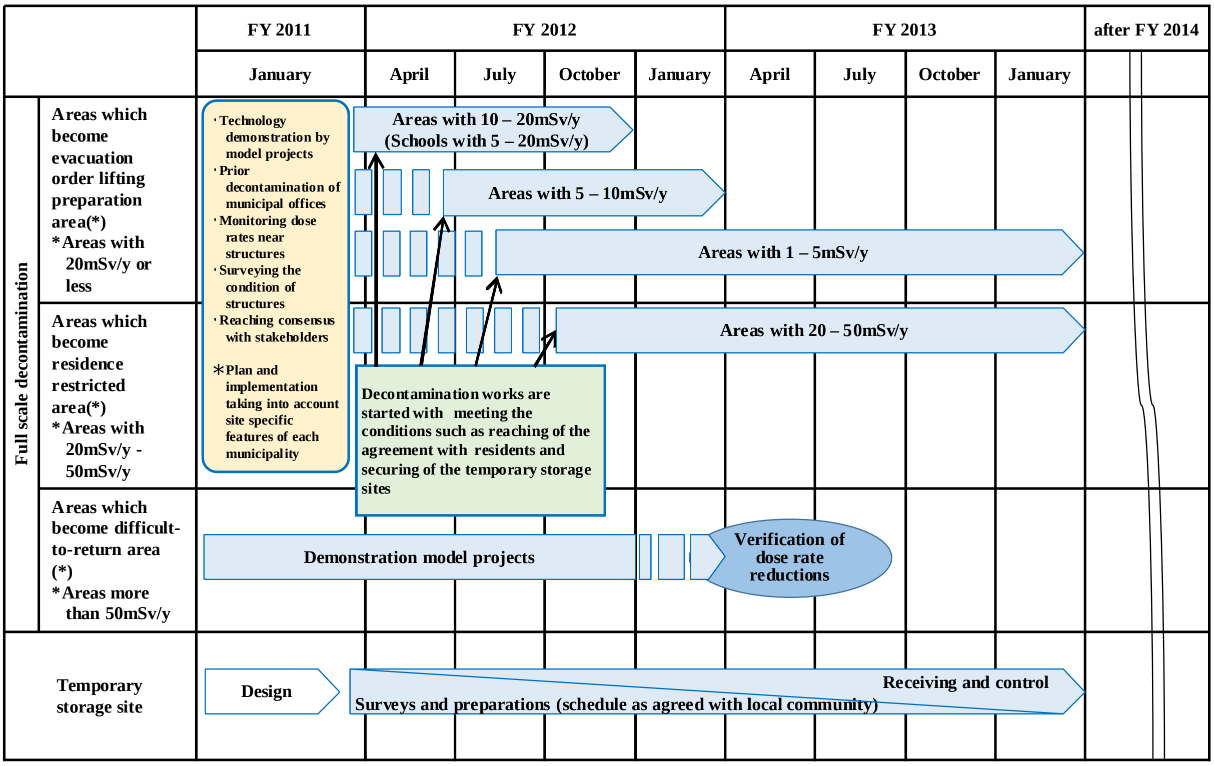



Figure 1-19 Decontamination roadmap for each new evacuation order area.

○By around the end of this fiscal year, decontamination implementation plan for special decontamination areas will be developed. Based on the plan, full-scale decontamination works should be performed.

○ Evacuation areas will be reviewed and classified into three new evacuation areas based on the level of air dose rate, and decontamination will be implemented in cooperation with the perspectives of recovery and reconstruction.

○ The prospects for securing of the temporary storage sites, and the aspects of smooth securing of workers must be considered in the plan.

○ Model projects and prior decontamination are carried out parallel. The knowledge obtained through them is reflected appropriately .

**Policy for full-scale decontamination**

Areas which become evacuation order lifting preparation area(*) *Areas with 20mSv/y or less

- By around the end of 2012, aiming for the decontamination of the areas with 10 ~ 20mSv / y (Schools, etc. with 5 – 20mSv/y(1- 4μSv/h))
- By around the end of March, 2013, aiming for the decontamination of the areas with 5 ~ 10mSv / y.
- By around the end of March, 2014, aiming for the decontamination of the areas with 1 ~ 5mSv / y.
- Specific targets in the areas are reflected in the plan, taking also into account the results of the model projects.
- Aiming to less than 10mSv / y for the areas with 10mSv / y or more for the time being. Aiming at 1μSv/h or less for schools, which is a criteria of the reopening of the schools.

Areas which become residence restricted area(*) *Areas with 20mSv/y - 50mSv/y

- Aiming at decontamination from FY2012 to FY2013.
- Aiming at the reduction of the size of the areas step-by-step but as soon as possible.

Areas which become difficult-to-return area (*) *Areas more than 50mSv/y

- Carrying out model projects for the time being.

Implementation policies and targets of the specific decontamination for each municipality are developed flexibly in coordination with stakeholders.

**Main steps of the full-scale decontamination**

①Grasp of the caretakers (owners) of the land to be decontaminated
②Briefing session for Residents
③Agreement of the access to housing, etc.
④Radiation monitoring/Surveying the condition of structures, housing, etc.
⑤Reaching consensus for decontamination with caretakers
⑥Implementation of decontamination works

⇨ The development of the contents of this road map is planned and is utilized in planning and project implementation in future

Figure 1-20 Points for the policy on the decontamination in the Special Decontamination Area.

Along with these decontamination framework in the Special Decontamination Area, the MOE carried out detailed monitoring from November 7, 2011 through February 28, 2012, in the areas where the National Government should perform decontamination, and the air dose rate distribution was clarified to some extent based on the measurement results.

The Government also carried out decontamination model projects (see 1.1.6 for details), collected knowledge about the decontamination, and then developed the common specifications of decontamination works (“Common Specifications”) for the National Government to order decontamination works. Furthermore, the MOE held residents’ briefing sessions prior to performing preliminary decontamination works, and acquired the agreement of the residents before carrying out major decontamination works. At the stage when preparations for ordering of the decontamination works had been completed, the MOE ordered decontamination works using the Common Specifications for decontamination works.

It should be noted that not only the provision of education to decontamination workers but also the proper management of the decontamination works are important because of the large-scale of the decontamination works. Thus, various efforts were being taken for decontamination works (See Chapter 4 for details).

## （3） Review of decontamination implementation plans in the Special Decontamination Area

In the middle of fiscal year 2013 that is the last fiscal year of the original decontamination work period in Special Decontamination Areas, the MOE performed the “comprehensive check and review of the progress of decontamination works” (those findings were announced on September 10, 2013). The MOE discussed future decontamination plans with each municipality based on these results, and revised the decontamination implementation plans in the Special Decontamination Area to more realistic ones based on

Article 29, Clause 1 of the Act on Special Measures,. The outline is indicated below.

1）Outline of the comprehensive check and review

- The original target schedule, in which all the decontamination works had been planned to be completed and the wastes and soil to be transferred to temporary storage sites without exception within two years (by the end of March, 2014), should be revised to allow a flexible decontamination schedule in accordance with the situation of each municipality and progress of restoration.
- At that time, the measures to accelerate decontamination and to progress smoothly should be taken, and decontamination plans should be reviewed flexibly according to the progress of reconstruction.
- In Tamura City, decontamination works were completed in accordance with the decontamination implementation plan. In Naraha Village, Kawauchi Village and Okuma Town, decontamination works are aimed at completion in the fiscal year 2013 in accordance with the current plans and schedules. For Minami-soma City, Iitate Village, Kawamata Town, Katsurao Village, Namie Town and Tomioka Town, the MOE continues to coordinate planning with each municipality and will revise the current plans and schedule of works within the year. For Futaba Town, the development of the decontamination plan will be continued in coordination with reconstruction measures and the situation of the town.

2）Overview of the review of the plan

- For Minami-soma City, Iitate Village, Kawamata Town, Katsurao Village, Namie Town, and Tomioka Town, the comprehensive check and review in September decided to revise their decontamination plans by around the end of 2013. The revised realistic schedules are to be established through the consultation with each community concerned in view of current situations.
- Priority is to be placed on the decontamination of residential land and its neighborhood which is important for the residents' return. The implementation schedules of the decontamination works in each of the municipalities are shown in Table 1-3.
- Infrastructures, such as water supply, sewage systems and major roads should be decontaminated in advance in line with the progress of reconstruction activities by coordinating with related organizations.
- In implementing the projects, measures shall be taken to accelerate and advance the decontamination more smoothly, and to shorten the work period to the extent possible. The project schedules shall be thoroughly managed and the progress of the decontamination works shall be made transparent.
- Based on these, the decontamination plans in the subject six municipalities have been revised.

Table 1-3 Revised decontamination schedules[55]

| | |
|---|---|
| Minami-soma City | • The decontamination of residential land and its neighborhood is prioritized, aiming to be completed in the fiscal year 2015.<br>• The decontamination works of other places aim to be completed in the fiscal year 2016. Furthermore, efforts are made to accelerate and advance the decontamination more smoothly, and to shorten the work period to the extent possible. |
| Iitate Village | • The decontamination of residential land and its neighborhood is prioritized, aiming to be completed in the fiscal year 2014. Furthermore, efforts are made to accelerate and advance the decontamination more smoothly, and to shorten the work period to the extent possible, aiming at the completion by the end of the year 2014.<br>• The decontamination works of other places aim to be completed in the fiscal year 2016. Furthermore, efforts are made to accelerate and advance the decontamination more smoothly, and to shorten the work period to the extent possible, aiming at the completion by the end of the year 2016. |
| Kawamata Town | • The decontamination of residential land and its neighborhood is prioritized, aiming to be completed in the fiscal year 2014. Furthermore, efforts are made to accelerate and advance the decontamination more smoothly, and to shorten the work period to the extent possible, aiming at the completion in the summer of 2014.<br>• The decontamination works of other places aim to be completed in the fiscal year 2015. Furthermore, efforts are made to accelerate and advance the decontamination more smoothly, and to shorten the work period to the extent possible, aiming at the completion by the end of the year 2015. |
| Katsurao Village | • The decontamination of residential land and its neighborhood is prioritized, aiming to be completed in the fiscal year 2014. Furthermore, efforts are made to accelerate and advance the decontamination more smoothly, and to shorten the work period to the extent possible, aiming at the completion in the summer of 2014.<br>• The decontamination works of other places aim to be completed in the fiscal year 2015. Furthermore, efforts are made to accelerate and advance the decontamination more smoothly, and to shorten the work period to the extent possible, aiming at the completion by the end of the year 2015. |
| Namie Town | • The area-wide decontamination in the decontamination designated areas except for the tsunami disaster areas (Minamitanashio, Ukedokita, Ukedominami, Nakahama, Morotake) is prioritized, aiming to be completed in the fiscal year 2015.<br>• While taking into consideration the treatment status of disaster wastes in the tsunami disaster areas, the decontamination of residential land and its neighborhood is prioritized, aiming to be completed in the fiscal year 2015. The decontamination works of other places aim to be completed in the fiscal year 2016. Furthermore, efforts are made to accelerate and advance the decontamination more smoothly, and to shorten the work period to the extent possible. |
| Tomioka Town | • The decontamination of residential land and its neighborhood is prioritized, aiming to be completed in the fiscal year 2015.<br>• The decontamination works of other places aim to be completed in the fiscal year 2016. Furthermore, efforts are made to accelerate and advance the decontamination more smoothly, and to shorten the work period to the extent possible. |
| Futaba Town | • Coordination shall be continued for the development of the decontamination plan, taking into account the results of model projects, picture of reconstruction plan, and the level of radiation dose, etc. |

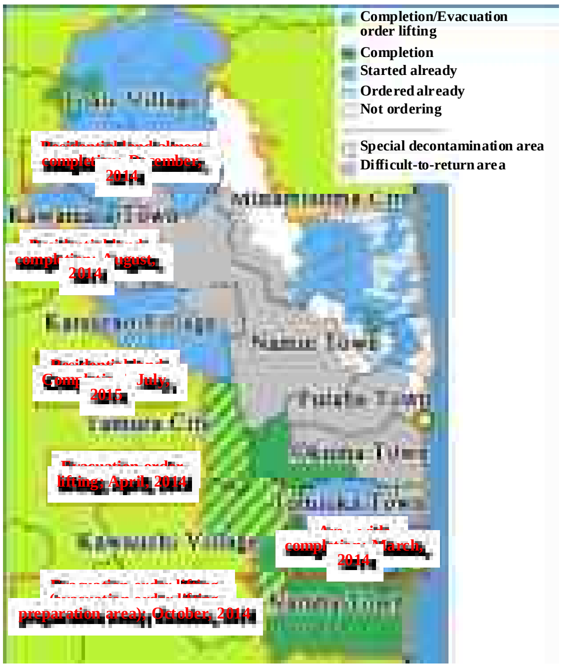
※For implementation of the decontamination works, developing the decontamination plan, securing the temporary storage sites, reaching agreement with land owners, and securing of workers are preconditions.

[55]Source: Ministry of the Environment (MOE), "Review of decontamination implementation plan in s" (December 2013)

## （4） Progress of the decontamination in the Special Decontamination Area

Figure 1-21 shows the decontamination status in the Special Decontamination Area as of March 2015.

Even in Futaba Town, where the schedule of decontamination works had been delayed, the decontamination implementation plan was developed and decontamination works are due to start soon. Meanwhile, in Tamura City and Kawauchi Town, decontamination works were completed, and all or part of the evacuation orders have been lifted.




| | |
|---|---|
| Tamura City | Completion of area-wide decontamination works in June, 2013<br>Lifting of the evacuation order on April 1, 2014 |
| Kawauchi Village | Completion of area-wide decontamination works in March, 2014<br>Lifting of the evacuation order in evacuation order lifting preparation area on October 1, 2014 |
| Naraha Town | Completion of area-wide decontamination works in March, 2014 |
| Okuma Town | Completion of area-wide decontamination works in March, 2014 |
| Joban Expressway | Completion of decontamination works in June, 2013<br>(Opening between the Hirono IC - Joban Tomioka IC on February 22, 2014 )<br>(Opening between the Namie IC - Minamisoma IC on December 6, 2014 )<br>(Opening between the Namie IC - Joban Tomioka IC on March 1, 2015 ) |
| Katsurao Village | Completion of decontamination works for residential land in July, 2014<br>Aiming at the completion of the works for other places in the year 2015 |
| Kawamata Town | Completion of decontamination works for residential land in August, 2014<br>Aiming at the completion of the works for other places in the year 2015 |
| Iitate Village | Aiming at the completion of decontamination works for residential land in the fiscal year 2015<br>Aiming at the completion of the works for other places in the year 2016 |
| Minamisouma City | Aiming at the completion of decontamination works for residential land in the fiscal year 2015<br>Aiming at the completion of the works for other places in the year 2016 |
| Namie Town | Aiming at the completion of decontamination works for the areas except for the tsunami disaster areas in the fiscal year 2015<br>For the tsunami disaster areas, aiming at the completion of decontamination works for residential land in the fiscal year 2015<br>and at the completion of the works for other places in the fiscal year 2016 |
| Tomioka Town | Aiming at the completion of decontamination works for residential land in the fiscal year 2015<br>Aiming at the completion of the works for other places in the year 2016 |
| Futaba Town | Aiming at the completion of decontamination works in the fiscal year 2015 |

Figure 1-21 Overview of the progress of decontamination works under the direct control of the National Government (as of March 2015)[56].

[56]Source: Ministry of the Environment (MOE), Produced based on "Progress of decontamination works under direct control of the National Government (as of March 2015) (https://josen.env.go.jp/material/pdf/josen_gareki_progress_201503.pdf)(Table 1-4 and Table1-5 are based on the same source)

## Table 1-4 Progress of decontamination works under the direct control of the National Government (1) (As of February 20, 2015)

| | | Decontamination areas Population (people) (total) | Size of decontamination (ha) (round) | Review of areas | Progress of decontamination (Other than the municipalities of the work completion; as of February 20, 2015) | | | | Schedule | | Evacuation order lifting |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Decontamination plan | Temporary storage sites | Agreement acquisition | Works | Residential land completion | Other places completion | |
| Area-wide completion; | Tamura city | 400 | 500 | H24/4 | H24/4 | secured already | Acquired | June, 2013 completion | FY2013 (already completed) | | April, 20144 |
| | Kawauchi village | 400 | 500 | H24/4 | H24/4 | secured already | Acquired | March, 2014 completion | FY2013 (already completed) | | Evacuation order lifting preparation area; October, 2014 |
| | Naraha town | 7,700 | 2,100 | H24/8 | H24/4 | secured already | Acquired | March, 2014 completion | FY2013 (already completed) | | Undecided |
| | Okuma town | 400 | 400 | H24/12 | H24/12 | secured already | Acquired | March, 2014 completion | FY2013 (already completed) | | Undecided |
| Residential land Completion | Katsurao village | 1,400 | 1,700 | H25/3 | H24/9 | secured already | Almost acquired | Working | 2014 summer (already completed) | In 2015 | Undecided |
| | Kawamata town | 1,200 | 1,600 | H25/8 | H24/8 | About 90 % | Almost acquired | Working | 2014 summer (already completed) | In 2015 | Undecided |
| | Iitate village | 6,000 | 5,600 | H24/7 | H24/5 | secured already | About 90 % | Working | In 2014 (almost completed) | In 2016 | Undecided |
| Under working/preparations | Minami-soma city | 13,300 | 6,100 | H24/4 | H24/4 | About 80 % | About 70% | Working | FY2015 | FY2016 | Undecided |
| | Namie town | 18,800 | 3,300 | H25/4 | H24/11 | About 40 % | About 70% | Working | FY2015 | FY2016 | Undecided |
| | Tomioka town | 11,300 | 2,800 | H25/3 | H25/6 | secured already | About 90 % | Working | FY2015 | FY2016 | Undecided |
| | Futaba town | 300 | 200 | H25/5 | H26/7 | Adjusting | Preparing | Preparing | FY2015 | | Undecided |

**Table 1-5 Progress of decontamination works under the direct control of the National Government (2) (As of February 20, 2015) (unit :%)**

| As of 20th February, 2015 | Tamura City | | Naraha Town | | Kawauchi Village | | Iitate Village | | Kawamata Town | | Katsurao Village | | Okuma Town | | Minami-soma City | | Tomioka Town | | Namie Town | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Implementation rate | Order rate | Implementation rate | Order rate | Implementation rate | Order rate | Implementation rate | Order rate | Implementation rate | Order rate | Implementation rate | Order rate | Implementation rate | Order rate | Implementation rate | Order rate | Implementation rate | Order rate | Implementation rate | Order rate |
| Residential land | 100 | 100 | 100 | 100 | 100 | 100 | 96 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 7 | 99.9 | 17 | 100 | 11 | 48 |
| Farmland | 100 | 100 | 100 | 100 | 100 | 100 | 25 | 100 | 18 | 100 | 68 | 100 | 100 | 100 | 8 | 65 | 5 | 100 | 13 | 35 |
| Forest | 100 | 100 | 100 | 100 | 100 | 100 | 38 | 100 | 56 | 100 | 99.9 | 100 | 100 | 100 | 34 | 79 | 28 | 100 | 14 | 43 |
| Road | 100 | 100 | 100 | 100 | 100 | 100 | 24 | 100 | 4 | 100 | 32 | 100 | 100 | 100 | 2 | 65 | 61 | 100 | 20 | 46 |

Note 1) Implementation rate is the percentage of the sizeof a completed series of decontamination works (weeding, sediment removal, washing, etc.), to the size of decontamination objects in each municipality.
Note 2) The order rate is the percentage of the contracted size to the size of decontamination objects in each municipality.
Note 3) Size of decontamination objects, ordering size, and the size that ordering acts have been finished may be changed with future surveys.

### 1.1.6. Overview of the demonstration model projects for decontamination

This section excerpts the outline of the report on the demonstration model projects for decontamination prepared by the Cabinet Office[57], which was positioned in the decontamination plans in the Special Decontamination Area indicated in 1.1.5.(1).

Through these projects, knowledge and decontamination technologies were confirmed. In particular, the following points were seen: the importance of monitoring to prevent any hot spot from being overlooked; the importance of such obvious work environment preparations as procurement and supply of decontamination-related goods including the securement of water supplies to push forward decontamination works; the impact of winter weather on decontamination works; implementing effective measures to maintain the quality of large-scale decontamination works; considering the possibility of re-contamination; having effective strategies to prevent recontamination; and having effective measures to reduce the volume of wastes. Moreover, it was also necessary to understand the anxiety of residents to decontamination works and to make sure radiation protection for decontamination workers.

The results obtained in these projects are shown in the following (3) (4), and particularly important findings are shown in (7).

#### （1） Objectives

The main objectives of the demonstration model projects for decontamination were to establish: the methods for efficient and effective decontamination; and the safety measures relating to radiation protection of workers for the areas mainly with high radiation exposure dose in which the annual additional exposure dose exceeds 20 mSv.

Specifically, an area of constant size for model project implementation was set in each of the 12 municipalities (Tamura City, Minami-soma City, Kawamata Town, Hirono Town, Naraha Town, Tomioka Town, Kawauchi Village, Okuma Town, Namie Town, Katsurao Village, Iitate Village, and Futaba Town[58]) belonging to restricted areas and deliberate evacuation areas. In those areas, the verification and the evaluation of the decontamination effect were carried out for the decontamination methods and

[57]Source: Ministry of the Environment (MOE), "The overview report on the demonstration model projects for decontamination in restricted areas and deliberate evacuation areas (Final revision)" (June, 2012)
[58]Futaba Town had also been included in the implementation areas of the model projects at first. However the implementation has not been done because Futaba Town canceled the project.

technologies to be considered practical. And then, the data which would be utilized in the implementation of the future full-scale decontamination projects were acquired and prepared to be used immediately.

In addition, the results of these efforts were to be presented in the form of guidelines that could be used as the reference sources by the National Government and local governments, etc. when performing decontamination works.

## (2) Implementation scheme and decontamination target areas

The target municipalities of the decontamination model projects for decontamination were divided into three groups of A, B and C by JAEA, which was commissioned from the National Government for the projects. In each group, Joint Ventures (JVs) performed the verification tests of decontamination technologies based on their proposals for the decontamination submitted responding to the public call for proposals by JAEA[59].

Target areas in each group and decontamination targets are shown in Table 1-6.

[59]For the decontamination model project, Group A, Group B, Group C have been implemented by Taisei JV, Kashima JV, and Obayashi JV, respectively.

Table 1-6 Target areas of the decontamination model projects in each municipality[60]

| Groups/Municipalities | | Target areas for the decontamination model projects | Decontamination target (Total about 209 ha) Main components/ features | Size |
|---|---|---|---|---|
| Group A | Minami-Soma City | Kanebusa Elementary School and surrounding area | Farmland, Building (Elementary School), Road, Forest, Residential land | approx. 13ha |
| | Kawamata Town | Sakashita area | Farmland, Road, Forest, Residential land | approx. 11ha |
| | Namie Town | Tsushima area | Building (Junior High School, etc.), Road, Forest, Residential land | approx. 5ha |
| | | Gongendo area | Building (Station, Orbit, Library, etc.), Private house, Farmland, Road | approx. 13ha |
| | Iitate Village | Kusano area<br>Base of "Patrol Team for the Entire Iitate-mura" | Building (Manufacture, Iitate home, etc.), Farmland, Private house, Residential land, Road, Forest | approx. 17ha |
| Group B | Tamura City | Jikenjo area | Farmland, Residential land, Road, Forest | approx. 15ha |
| | Katsurao Village | Katsurao Municipal Office and surrounding area | Farmland, Private house, Residential land, Road, Forest , Residential land, Road, Forest | approx. 6ha |
| | Tomioka Town | Yonomori Park | Building (Junior High School, Ground, etc.), Road (row of cherry blossom trees), Residential land, Forest | approx. 9ha |
| | | Tomioka Daini Junior High School | | approx. 3ha |
| | Futaba Town | — | — | — |
| Group C | Hirono Town | Chuo-dai/Nawashirogae area | Building (Government Office, Elementary /Junior High School, Ground),Residential land, Forest, Road | approx. 33ha |
| | Okuma Town | Okuma Municipal Office and surrounding area | Building (Government Office, Community Center, Park),Residential land, Road | approx. 6ha |
| | | Ottozawa area | Farmland, Residential land, Road, Forest , | approx. 17ha |
| | Naraha Town | Kamishigeoka area | Farmland, Residential land, Road, Forest | approx. 4ha |
| | | Minami Industrial Complex | Building (Factory, etc.), Road | approx. 37ha |
| | Kawauchi Village | Kainosaka area | Farmland, Private house, Road, Forest | approx. 23ha |

※1ha=10,000m$^2$

[60]Source: Ministry of the Environment(MOE), "The overview report on the demonstration model projects for decontamination in restricted areas and deliberate evacuation areas (Final revision)", (June, 2012)

### (3) Overview of the results for decontamination targets

#### 1) Residential land

##### A) Deposition status of radioactive cesium

- Large amount of radioactive cesium remain in the places where dust particles (soil) are carried by rainwater and accumulated (such as gutters and rain spouts).
- In addition, other than the places where rainwater accumulates, radioactive cesium tends to be deposited on and remain in the soil surface layer of residential gardens, concrete slabs on inclined surfaces, and asphalt surfaces.
- Surface contamination levels of vertical outer walls, on which dust particles carried by rainwater do not accumulate, are relatively low.
- As a result of investigating the deposition and retention status of radioactive cesium for different roof materials of houses (unglazed tiles, glaze tiles, cement roof tiles, galvanized iron), the largest amount of deposited radioactive cesium was for cement roof tiles. The deterioration of the surface condition of the cement tiles is considered to have influenced the deposition and retention.
- The amount of deposited radioactive cesium was relatively small for galvanized iron and slate.
- Moreover, radioactive cesium tended to be deposited and retained at specific spots on the roof.
    - ✓ Overlaying places of roof materials (such as tiles and galvanized iron)
    - ✓ Peeled portions of surface finishing (glazed or painted portions of roof tiles), rusted or corroded portions of roof materials
    - ✓ Dirty areas or tree sap adhering points on the roof.
    - ✓ The portions of tiles to prevent snow from sliding off of a roof, such as snow guards
- The dose rate of residential land was reduced overall by the decontamination works in the land. However it was found that the dose rate after the decontamination in the following places had the tendency to be slightly higher than other places. Those places were the regions where the implementation of decontamination works was difficult, such as narrow spaces, and around garden trees and other obstacles.

##### B) Decontamination methods and results

- High decontamination effect could be achieved by forcefully removing most of the deposits in gutters and then wiping off the remaining small deposits.
- It was observed that the decontamination effect on a roof varied according to the materials.
    - ✓ Brushing with a deck brush was effective for unglazed tiles and painted iron plates.
    - ✓ Manually wiping the surface was also effective for unglazed tiles.
    - ✓ Coating release agent had a relatively high decontamination effect compared to other methods for slate or cement roof tiles.
    - ✓ For cement roof tiles, decontamination effect was limited in all decontamination methods.
- Decontamination of the roof with a coating release agent provided a certain degree of decontamination and had a merit that it did not scatter the removed substances to the surroundings. However, it required covering the surface to be decontaminated with a protective material for 1-3 days and the temperature must be controlled inside the covering in winter. Therefore, its usability was limited and it was generally not practical.
- Decontamination of outer walls was carried out using the methods of "hand washing", "wiping off ", "high pressure water washing", and "brushing" for each material of tin, sash, glass, and wood. Even if the decontamination methods for outer walls were different, no big difference was confirmed in the surface contamination density after decontamination.
- Decontamination of gutters was performed using “wiping off” and “high-pressure water cleaning”. No significant difference was seen in their decontamination effects. “Wiping off” had better usability from the fact that contaminated wash water was not scattered to the surroundings.
- Decontamination of concrete (earthen floors) was carried out using high pressure water

washing. The effect of decontamination using high pressure water washing only was limited. When a relatively small area was targeted in the decontamination, surface cutting with the dust collection sander was effective for decontamination. However, it was not effective when a large area was targeted in decontamination, and it needed a dry surface condition. In addition, even if other methods such as metal brushes were used together with high pressure water washing, their effect on decontamination did not change.

- For gardens, the removal of gravel, etc. under rain gutters that had become hot spots had a significant effect for decontamination.
- It was found that air dose rates inside a building were reduced after the areas surrounding the building, and the degree of dose reduction was almost the same indoors and outdoors regardless of the material of the building (a concrete or a wooden building). Thus, in order to aim at reduction of indoor radiation level, decontamination of the area around the building is important.

### 2）Large buildings

#### A) Deposition status of radioactive cesium

- Large amounts of radioactive cesium remain in places where dust particles, which were deposited on large buildings, have been carried by rainwater and accumulated in certain areas (such as gutters and rainspouts). On the contrary, the amount of radioactive cesium was relatively small in the places where dust particles were just carried by rainwater and did not accumulate.
- It was confirmed that the radiation doses were higher in the places where dust particles were accumulated, or moss was growing, or in the drainage paths of rainwater, than those doses in their surrounding areas.
- Surface contamination levels of vertical walls of large buildings, on which dust particles carried by rainwater did not accumulate, tended to be low compared with those of concrete slabs on inclined surfaces or asphalt surfaces. On the other hand, contaminated vertical walls were also observed according to the movements of raindrops.

#### B) Decontamination methods and results

- The high-pressure water washing was effective for the decontamination of concrete roof with waterproofing.
- For the roof of concrete (mortar), decontamination effect was limited in all methods of “high pressure water washing (about 10 MPa)”, “high pressure water washing and brushing”, “nano-bubble washing”, and “special solution washing such as by oxygenated water”.
- The decontamination of outer walls was carried out using the methods of "wiping off " and "high pressure water washing" for each material of tin, sash, glass, and wood. Even if the decontamination methods of the outer walls were different, no big difference was confirmed in the surface contamination density after decontamination.
- “Wiping off” has better usability at a point from the fact that contaminated wash water is not scattered to the surroundings.
- It was found that the decontamination effect outside a building had influenced in reducing the air dose rates inside. This is considered to be due to reduced radiation from the radioactive materials outside which had been detected inside.

### 3）Farmland

#### A) Deposition status of radioactive cesium

- In most cases, 80% or more of the radioactive cesium inventory was present in the surface soil layer down to a depth of about 5 cm.
- It was observed that radioactive cesium penetration depth was deeper in the fields that had been plowed just before the accident.
- No remarkable difference was seen in the tendency for deposition and retention of radioactive cesium among rice fields, crop fields and orchards.

### B) Decontamination methods and results

- An effective approach involves confirming the depth distribution of radioactive cesium; determining the practical depth and efficiency of dose reduction methods of mixed tillage, reversal tillage, interchanging topsoil with subsoil, or topsoil stripping; and performing the most effective reduction method.
- In addition, the magnitude of dose reduction efficiency was approximately in the order of "mixed tillage <reversal tillage < (or =) interchanging topsoil with subsoil topsoil stripping".
  On the other hand, the amount of removed soil was in the order of "mixed tillage reversal tillage interchanging topsoil with subsoil << topsoil stripping".
- The effectiveness in dose reduction by reversal tillage or interchanging topsoil with subsoil, which does not produce soil for removal, was equivalent to that by topsoil stripping.

## 4) Roads

### A) Deposition status of radioactive cesium

- Roads (paved) tended to have low air dose rates compared with soil surface of the surrounding farmland and bare ground, etc. This is believed due to the fact that radioactive materials deposited on the paved surface of the roads were washed away by rainfalls after the accident.
- Depth distribution of the surface contamination density of asphalt paved surfaces in high-dose areas has been measured. As a result, it became clear that most of the radioactive materials remained down to a depth around 2-3 mm from the surface for pavement face of dense grain-size, and down to a depth around 5 mm from the surface even for porous asphalt pavement (permeable pavements, etc.).
- From the relationship between the surface dose rate and surface contamination density, the value of the surface contamination density may be relatively high on some roads (paved surfaces). Radioactive cesium is unevenly distributed near the pavement surface in comparison with the soil surface of the surrounding farmland and bare ground. Thus, it is considered that the contribution to the surface contamination density by beta ray having a short range distance in solids is remarkable. This also corresponds to the distribution in the depth direction of the contamination density of radioactive materials.

### B) Decontamination methods and results

- As decontamination methods for paved roads, "stripping-off" had a large efficiency of dose reduction, but generated larger quantities of removed wastes compared with other methods. Most of the inventory of radioactive materials was found to be present in a surface layer of asphalt, down to a depth of a few millimeters. Thus, it is possible to achieve a high decontamination effect, while minimizing the volume of wastes generated, by surface shaving off only this thickness.
- In comparison with "stripping-off (surface removal)", "washing" has the advantage that it does not generate wastes as in the case of surface removal or surface stripping-off. However, the efficiency of dose reduction is not high, and the collection and disposal of wash water are necessary.
- For asphalt paved surfaces, decontamination by "surface stripping-off or surface removal (water jet, shot blasting, TS cutting machine[61], etc.)" was more effective than "cleaning (dry road sweeping, etc.)" and "washing (high-pressure washing or use of vehicles for functional recovery, etc.)"
- "Surface stripping-off or surface removal" methods require machines and are difficult to be applied to areas in the vicinity of buildings and outer walls. Irregularities in the effect of dose reduction occurred for the roads with distorted and worn surfaces.

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[61] These were road surface cutting machines that scrape off asphalt paving or concrete paving by a rotary blade.

### 5）Parks and playing grounds

#### A) Deposition status of radioactive cesium

- The tendency was observed that more than 80% of the radioactive cesium deposited within the depth around 5 cm from the surface in most places.
- The tendency was strong that radioactive cesium deposited and remained in degraded rubber playground equipment and rusted metal playground equipment. On the other hand, the tendency that radioactive cesium deposited and remained in metal playground equipment with a smooth surface was weak.

#### B) Decontamination methods and results

- Wiping was effective in dose reduction for playground equipment with the smooth plastic surfaces. For metal playground equipment with rusted areas, cleaning with scrubbing brushes was effective for dose reduction, although it was limited.

### 6）Forests and trees

#### A) Deposition status of radioactive cesium

(Evergreen forests)

- The tendency was observed that the residual radioactive cesium was remaining higher in litter layers containing the fallen leaf layer which was formed newly during 2011
- It was observed that the amounts of residual radioactive cesium were small in the bark portions of tree trunks in comparison with other parts. It is thought that most of the radioactive cesium deposited in the leave and the branches and could not reach the trunk part.
- Radioactive concentration of fallen leaf layer formed by dropping of leaves which grew at the time of the accident (the surface layer that was formed by the newly fallen leaves during the year of the accident) was high compared with deciduous trees. It is thought that in evergreen trees, much more radioactive cesium deposited on the leaves, which grew at the time of the accident, compared with other parts.

(Deciduous forests)

- It was found that much radioactive cesium was depositing and remaining in the litter layer and outer bark of the trees. It is thought that this was because not many leaves had grown at the time of the accident.
- The amount of residual radioactive cesium has been compared between the fallen leaf layer which was formed during the year of the accident and the fallen leaf layer which had been formed before the accident under the fallen leaf layer during the year of the accident. As a result, the former (fresh layer) had a generally smaller quantity of radioactive cesium compared with the latter (older layer). This is also considered to be because not many leaves had grown at the time of the accident, most of the radioactive cesium that fell on deciduous trees was deposited on the ground surface under the trees, and then, the accident year’s fallen leaf layer was formed on the contaminated ground surface.

#### B) Decontamination methods and results

- Implementing both "weeding" and "removal of the accident year’s fallen leaf layer" may have (limited) effects of dose reduction in evergreen forests.
- On the contrary, in deciduous forests, surface contamination density was increased by implementing both "weeding" and "removal of the accident year’s fallen leaf layer". It is considered that, at the time of the accident, radioactive cesium deposited on the ground surface; The ground surface was covered afterwards by new grasses which grew thickly and the accident year’s fallen leaves without radioactive cesium contamination; and the radiation from the ground surface was shielded by them.
- It was observed that surface dose rate and surface contamination density were reduced to a

certain extent by "removing the litter layer" in addition to "weeding" and "removal of the accident year's fallen leaf layer" for both deciduous forests and evergreen forests. However, it is necessary to consider that removal of the litter layer may have impacts on forest ecosystems, such as changes in nutrient of soil.

- High-pressure water washing for trunks of trees with some barks peeled off but with no adverse effects on their growth had high decontamination effects.

## (4) Outline of results for works associated with decontamination

### 1) Disposal of wash water

- Effluent criteria were able to be satisfied by using the combined processing methods of filtration, adsorption, and coagulation/sedimentation, according to the degree of contamination of wash water in each spot (including the stagnant water in side ditches) or stagnant (pond) water before the accident.

### 2) Volume reduction methods of removed wastes such as branches and leaves

- Crushing machines could reduce volume of branches and leaves while preventing scattering of dust with deposited radioactive materials to the surroundings by applying dust collection measures. However the volume of logs was not reduced so much, because logs were not so bulky even before crushing.
- High temperature incineration could achieve extremely large volume reduction of branches and leaves without spreading of the radioactive materials deposited on them together with the exhaust smoke to the outside. Furthermore, it was confirmed that cesium concentration in the exhaust gas was sufficiently lowered below the concentration limit of radioactive materials in air specified by the law when treating the flue gas with bag filters or HEPA filters.
- Low temperature incineration was lower in volume reduction ratios than high temperature incineration or crushing machines.

### 3) Generated amount of removed wastes

- Generated amount of removed wastes greatly depends on differences in the decontamination methods rather than the differences in annual cumulative dose of decontamination implementation areas.
  - ✓ If the decontamination methods such as "topsoil stripping", "weeding", "removal of fallen leaves, etc." are selected for decontamination works, larger amount of removed wastes is generated.
  - ✓ As shown in (3) 3), the effectiveness in dose reduction by "inversion tillage" or "interchanging topsoil with subsoil" is equivalent to that by "surface soil stripping-off". However, "inversion tillage" or " interchanging topsoil with subsoil" does not result in the generation of waste removed soil.
- More than 80% of radioactive materials can be reduced in most places by removing surface soil to approximately 5 cm, regardless of the level of annual cumulative dose and land-use classification. However, the thickness of the stripping that directly relates to the amount of generated soil to remove should be set in consideration of both the vertical distribution of radioactivity concentrations and the decontamination targets.
  - ✓ The vertical distribution of radioactive material concentrations in the ground has a tendency that the reduction rate of the concentration (the rate of concentration decrease per each 1 cm in depth) significantly decreases as it goes deeper (exponentially decreasing)
  - ✓ For example, when 80% of the radioactive materials are included in the top 5 cm of the ground and 90% in the top 8 cm, the additional dose reduction of 10% is expected by removing the additional layer of 3 cm below 5 cm deep in comparison with removing the top 5 cm for removing 80% of radioactive materials. However, the amount of removed objects would increase by 60%..

- ✓ Surface soil may have to be stripped off more deeply to lower the density of radioactive materials of the topsoil below the fixed absolute value in the areas with high annual cumulative dose.
- ✓ However, the concentration distribution of radioactive materials in the underground depth direction may be different from that of the demonstration model projects for decontamination implemented to date, depending on unevenness of the ground surface and other factors. Therefore, the concentration distribution of radioactive materials in the ground depth direction should be checked first before starting decontamination works, and then the stripping thickness to achieve the decontamination target needs to be determined.

### 4）Temporary storage sites/on-site storage sites

- When installing temporary storage sites and the like, the planned sites must be decontaminated in advance and appropriate shielding measures have to be taken after the wastes are loaded and emplaced. Therefore, air dose rates in temporary storage sites do not increase but rather decrease after loading and emplacement of wastes, regardless of the level of air dose rates of the sites before installation.
  - ✓ Air dose rates are also reduced by covering removed wastes with sandbags filled with uncontaminated soil.
  - ✓ When bringing the removed objects into the storage sites and placing them therein, the radiation influence from those with high surface dose rates can be reduced by placing them at the center of the site, and those with lower surface dose rates are placed around them. By doing so, the influence of radiation from the removed objects with high surface dose rates can be reduced by the shielding effect of the removed objects themselves.
- Types of temporary storage sites have to be selected based on the opinions of municipalities and residents, and taking into account topographical characteristics, land use situation, and available area of the target sites.
  - ✓ Aboveground storage is the easiest type for shipment of stored wastes to the Interim Storage Facility. On the other hand, when installing the storage sites on soft ground, it is necessary to improve the foundation.
  - ✓ Underground storage has the advantage that the soil for the shielding can be secured at the sites. On the other hand, it takes time to excavate the underground portion, and measures have to be taken, for instance, for stopping groundwater inflow.
  - ✓ For semi-underground storage, it is possible to increase the storage capacity even for a limited place of the sites. However, it takes time to excavate the underground portion. In addition, it is necessary to apply rainwater infiltration measures at the boundaries of the aboveground portion and the underground portion.

### 5）Radiation exposure dose control of decontamination workers

- Exposure doses of decontamination workers were studied for each decontamination target area. The workers in areas with higher air dose rates monitored before decontamination generally had higher exposure doses. Nevertheless, exposure doses of workers in the areas with annual cumulative dose less than 50 mSv and with appropriate measures for exposure control were well below the reference value of the exposure dose limit stipulated by laws and ordinances.
- On the other hand, exposure doses of workers in the areas exceeding the annual cumulative dose of 50 mSv may exceed the exposure dose limit stipulated by laws and ordinances, if they work continuously for five years in those areas. Therefore, in such cases, more stringent radiation control is required, such as optimizing the combination of decontamination methods and work procedures for dose reduction, and promoting the work efficiency by utilizing machines.

### 6）Costs for each decontamination method

- Costs required for the works using the decontamination methods which bring larger dose reduction effect tend to be higher.
- It should be noted that, as can be seen in the following cases, it is necessary to consider overall factors including costs, the volume of removed wastes to be generated, and workability in addition to the dose reduction effect, when selecting decontamination methods.
  - ✓ The case in which different decontamination methods with the same level effect of dose reduction have different features regarding costs, the generated amount of removed wastes, and workability.
  - ✓ The case in which different decontamination methods with the same level effect of dose reduction and cost requirements have different features of workability.

## （5） Results of the implementation of area-wide decontamination works in demonstration model projects for decontamination

- Decontamination works were carried out in the areas where the radiation level before decontamination had been higher than the level to cause the annual cumulative dose of 20 mSv or more and below 30 mSv. The works cold reduce the radiation level to cause the annual cumulative dose below 20 mSv.
- Decontamination works were also carried out in the areas where the air dose rate before the works was higher than the level to cause the annual cumulative dose exceeding 40 mSv. After the works, the air dose rate could be reduced by around 40-60%. However, it was not possible to reduce the level to a level to enable the annual cumulative dose below 20 mSv.
- Decontamination work was carried out in Ottozawa area, Okuma Town, where the air dose rate before the works had been at the level to cause 300 mSv or more as the annual exposure dose. After the works, the air dose rate could be reduced more than 70% in farmland and residential places. However, the air dose rate was not able to be reduced to a level to achieve 50 mSv/year or less for the whole area.
- In some areas with lower air dose rates before decontamination, decontamination methods that do not generate much waste were tested. Although the amount of removed wastes was relatively small, the reduction in air dose rates was lower compared with the case in higher air dose rate areas.

## （6） Guidance on decontamination works

The findings obtained in the demonstration model projects for decontamination are summarized in the form of guidance[62] and have been published for the following eight items.

- Guidance on obtaining informed consent (agreement acquisition) concerning the decontamination implementation areas, selection of temporary storage sites and their stakeholders
- Guidance on monitoring
- Guidance on decontamination works
- Guidance on preparation and maintenance for temporary storage sites/on-site storage sites
- Guidance on screening (contamination inspection)
- Guidance on the treatment of wastes generated by decontamination works
- Guidance on workers' occupational safety management
- Guidance on supervision for outsourcing companies

[62]Source: published on JAEA home page (http://fukushima.jaea.go.jp/initiatives/cat01/entry02.html )

### (7) Important findings obtained in demonstration model projects for decontamination

#### 1) Important findings obtained for establishment of the work environment

- In restricted areas, it is important to secure site offices and rest places which serve as bases in decontamination works and securing water for decontamination. If rest places are not secured in time, the limitation occurs in the length of working hours in which workers can work continuously. If water cannot be secured on site, it must be brought from outside the restricted areas. As the facilities for rest places and the like, it was effective to utilize public grounds and public facilities, because coordination with the persons concerned for their use could be made in a short period of time.
  Machinery and equipment to be used for decontamination works might be possible to procure on a, lease contract, but there were cases in which to bringing them into the restricted area was refused. When procuring them on a lease contract, it is necessary to provide sufficient information to the lease companies on the appropriate contamination inspection of the machinery and equipment, and the appropriate decontamination methods to apply when needed and other conditions, and to clear the concerns of these companies.
- Damage conditions of houses were investigated by outsourced specialty companies. The contents of the investigation were based upon a construction damage investigation of damage possibilities by decontamination works. The investigation did not include applicable environmental conditions and construction constraints for decontamination works, for example, investigations to determine whether it was possible to set up scaffolding on roofs for the works were not included. Therefore, it will be an efficient approach in the damage survey of houses for the subsequent decontamination works, not only investigating the damage conditions, but also checking whether the houses are in such environmental conditions in which appropriate decontamination methods for the houses concerned can be applied technically, and whether there are concerns about construction constraints for decontamination works.
- For large-scale decontamination works, there may be many places where wash water is produced. Therefore, difficulty was foreseen to set up water treatment facilities in one place for a long term. For this reason, a water treatment system, such as a vehicle-mounted one, should be considered, which can move to the places where the wash water is generated.

#### 2) Important findings obtained for monitoring

- Regarding the monitoring to locate hot spots, there were cases which caused the residents' complaint. Such cases occurred when the hot spots could not be located in the pre-monitoring stage and they were found later by the residents' own measurement after the decontamination works. Important knowledge obtained regarding monitoring is:
  - ✓ It is necessary to set the number of monitoring points per house in a flexible way, not to fix it at a certain number, in order to prevent overlooking of the necessary decontamination works.
  - ✓ In mesh measurements, the measurement in shorter pitches gives better accuracy, but the workload increases instead. For optimization, a combined use of back-pack type or buggy type instruments in mesh measurements was more effective than expanding the measurement pitches of mesh measurements for preventing the overlooking of hotspots.
  - ✓ For locating hotspots, it was effective to search for a place where the air dose rate was relatively higher than other places in the surrounding by the measurement device with shortened time constant for higher sensitivity. A two-dimensional dose rate distribution evaluation system, which combined a GPS device and a dosimeter, was an effective tool for locating hotspots because of its high spatial resolution, no requirement of high measuring skills, and less data variation of measurements, and less risks of overlooking hotspots.
- Risks of overlooking hotspots could be minimized by post-work monitoring by the work leaders as a means of work result management, in order to locate any spots with high dose rate or high surface contamination densitiesleft behind. So was for the soil and wastes to be removed.

3）Important findings obtained for the influence of winter weather on decontamination

- Generally in the snowfall, the measured radiation dose becomes lower due to the shielding effect of the snow on the ground. In the demonstration model projects for decontamination, the reduction effect of dose rate due to snow was evaluated quantitatively. As the result rough evaluation of dose rate has become feasible even when snow-covered.
- Machinery and equipment for decontamination may be subjected to freezing in midwinter and the working efficiency may be significantly affected. It has been recognized that anti freezing measures should be considered, by keeping them in shelter, for instance.
- Sometimes the soil solidifiers did not work for topsoil stripping during the winter because of low temperatures. In some other cases, the frozen layer of topsoil was stripped off up to the frozen depth at one time, thicker than the preset thickness to strip. The amount of removed objects thus increased. On the other hand, however, it has been recognized that the surface soil could be stripped off effectively by using road surface cutting machines.
- Following risks have been also recognized: Frozen top soil when stripped off or frozen soil for shielding may increase the amount of seepage water after they are transferred to the temporary storage sites; flexible container bags for shielding (hereinafter referred to as "flexible containers") may deform and subside; or the welded portion of impervious sheets may fail. Furthermore, risks of deformation of water collection boxes have been also noticed.

4）Important findings obtained for maintaining the quality of decontamination works

- A tendency was noticed in decontamination works that the decontamination effects varied depending on the work methods of individual workers. Particularly, in top soil stripping, soil was occasionally spilled during plowing regardless of hand work or machine work. This has been noticed as one of the causes for differences in the decontamination effects.
- When decontaminating by top soil stripping with the stripping thickness under control, grass roots in the actual soil surface impeded stripping off in the predetermined thickness, Sometimes it became necessary to remove grass roots and then to strip the topsoil off beyond the predetermined thicknesses. In the land with irregularities, it was also necessary to strip off thicker layers than the predetermined values. In order to reduce the deviation from the predetermined stripping thickness, prior rolling compaction has been effective.
- It has been found that both coagulating sedimentation method and filtration method had advantages and disadvantages for the treatment of recovered wash water. For example, for the coagulating sedimentation method, the device is simple and it is easy to use, but the process such as water removal from the sediment and solidification of the sediment is required. On the other hand, in the filtration method, residues are solid and it is easy to handle them. However, it takes time to complete the filtration, and measures such as the reverse washing because of blocking of the filter are required. In addition, while the coagulating sedimentation method is a batch process, the filtration method can be run continuously. It is difficult to recommend unconditionally which processing method can be used for recovered wash water. This is because the process to be used varies according to the properties of treated water and the required amount of processing. As a result, the use of the processing method according to the situation or the use of a combination of processing methods is effective for treating recovered wash water.

5）Important findings obtained for the prevention of re-contamination

- The places that had been decontaminated were distinguished using colored cones and other means, and furthermore measures were taken to prohibit entering those places at the time the decontamination works were being done. These actions were effective for the prevention of re-contamination.
- It should be noted that, in the demonstration model projects for decontamination, daily monitoring has been carrying out continuously at the fixed points, including the points where individual decontamination works had been completed. As a result, during the period

of around one month from the end of the decontamination works to the end of the projects, hardly any situations such as a dose rate increase after the completion of decontamination works have been observed. In other words, the influence of significant secondary contamination have not been seen.

### 6) Important findings obtained for the volume reduction of wastes

- Among flammable decontamination wastes, branches and leaves generated from forests and the undergrowth of weeds such as the bamboo grass were bulky when stored in flexible containers. Therefore, the filling efficiency of the flexible containers could not be increased. Incineration was a very effective treatment method because the volume reduction rate was high and spread of radioactive cesium was suppressed by installing filters for the exhaust gas. However, it is necessary to note that the equipment is relatively large-scale and the incineration ash must be handled.
- Wood crushers and wood chippers were effective processing devices. This was because their volume reduction rate was relatively high although it depended on the processing targets, and the equipment was not large in scale. However, when wood chippers were used, it was desirable to take measures such as laying dust sheets around the equipment because the scattering of small pieces of wood is expected.
- For volume reduction of undergrowth generated from vast grasslands, compression by an undergrowth accumulation machine attached to a tractor (roll baler) was regarded as an efficient method from the viewpoint of volume reduction rate and work efficiency, although the human power to accumulate undergrowth of weeds was required.
- Volume reduction by compressing dead leaves with a heavy loader vehicle and volume reduction by sucking off air in sealed bags with large vacuum cleaners that can be easily carried into fields were other measures.
- Soil stripped from farmland (especially pastures) and playgrounds, schoolyards, parks (especially lawn areas) included large numbers of plant roots. It is very effective from the viewpoint of control of the waste amounts that the stripped soil portions are separated into soil and flammables (plant roots). In order to separate in this way, twisters[63] and vibration sieve machines were used. This technique cannot be evaluated with a numerical value of separation rate because separation depends on what are included as the non-flammables (such as soil and stones) and what are included as the flammables (such as plant roots). The results of the separation tests of soil and plant roots were confirmed by visual inspection. For test conditions that were good, flammables such as many roots were not included in the separated soil. Therefore, it was possible to control the separated soil as non-flammables. Consequently, this method was considered to be effective from the viewpoint of waste management. When highly viscous soil was treated (clay), the soil could not be broken by the twister and therefore a large amount of soil was separated to the root side (flammables). Thus, it was also found that it is necessary to pay attention to the soil properties.
- Combination treatment method was considered, in which grass roots that have been separated by the twister were processed by low temperature incineration using a rotary dryer[64]. In this case, all the wastes that were left after burning could be treated as non-flammables.

### 7) Important findings obtained regarding the anxiety of residents

- From local residents, including the landowners, and local governments, there were many requests to report the progress of decontamination works and the effect of dose reduction by decontamination. It has been found to be important to respond to these requests politely. To promote decontamination works while building the relationship of mutual trust with local governments and local residents, it was important that information control be implemented

[63] Twister (rotary crushing mixer) (Machinery for crushing and mixing the soil with striking force of a chain rotating at high speed)

[64] Rotary (tumble) dryer (Machine for heating and drying the soil containing moisture in a rotating tube)

without exception to prevent release of personal information, while ensuring that the information on the details and the results of the works were offered regularly as far as possible.

- Many concerns were voiced from residents regarding downstream contamination by wash water. Downstream contamination by wash water was found to be one of the biggest causes of uneasiness. Therefore, when decontamination works were carried out using water, it was important to take outflow prevention measures such as providing weirs in roadside ditches where wash water flowed into. In the case of high-pressure water washing of houses and garden planting, it was possible to prevent secondary contamination by removing concrete facings and surface soil under the planting and near the house after high pressure water washing.

#### 8）Important findings obtained for safety protection of the decontamination workers

- At the places where the levels of contamination were estimated to be especially low, it was considered at first that the wearing of sealed chemical protective clothing and a full-face mask was not always necessary, if post-work contamination checks of workers were thoroughly carried out. However, in the case of actual works, some workers could not feel relieved without wearing these protective items, and heavily equipped workers, who wore both the sealed chemical protective clothing and the full-face mask, were found here and there. Not only was it necessary to explain safety to workers scientifically, but also it was also important to remove workers' anxiety.
- For the workers, not only radiation protection but also measures to protect from pests (particularly bees and vipers) were necessary. In addition, it was found that measures to protect workers from the danger caused by livestock and pets which had gotten free from owners were necessary.
- It was not only residents that felt uneasy as to whether decontamination was carried out appropriately. It was found that there was a case in which workers were performing decontamination works while feeling uneasy whether the works were being carried out appropriately. Particularly, in the topsoil stripping by human power, it was difficult to check whether there was any omission of stripping or any unremoved soil by only visual inspection. Therefore, personnel qualified to make dose measurements were present in the fields during decontamination works, and the effect of dose reduction was confirmed in a timely manner. This was effective in the prevention of redoing of decontamination works and in the prevention of excessive decontamination.

### 1.1.7. Outline of the Intensive Contamination Survey Areas

#### （1） Designation of Intensive Contamination Survey Areas

Intensive Contamination Survey Areas are designated by the MOE as the areas where it is necessary to investigate and measure the status of the environmental contamination due to the radioactive materials discharged in the areas by the accident mainly.

In Intensive Contamination Survey Areas, designated municipal mayors have developed their decontamination plans unlike those of the Special Decontamination Areas as described in 1.1.4, and municipalities have been implementing decontamination works steadily.

#### （2） Designation status of Intensive Contamination Survey Areas

The designation status of Intensive Contamination Survey Areas is not fixed because there are also some areas where the designation was lifted after the determination[65]. The municipalities listed in Table 1-7 are the designated the Intensive Contamination Survey Area as of February 1, 2015. Municipalities designated

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[65] For some municipalities, the designation of Intensive Contamination Survey Area was lifted because the decrease in air dose rates led to the fact of the qualification for designation.

as the Intensive Contamination Survey Area and Special Decontamination Area are shown in Figure 1-22 through Figure 1-29, together with the progress of decontamination works in those municipalities.

**Table 1-7 Designation status of Intensive Contamination Survey Areas (as of February 1, 2015)[66]**

| Prefectures | Municipalities |
|---|---|
| Fukushima Prefecture | Fukushima City, Koriyama City, Iwaki City, Shirakawa City, Sukagawa City, Soma City, Nihonmatsu City, Date City, Motomiya City, Koori Town, Kunimi Town, Otama Village, Kagamiishi Town , Tenei Village, Aizubange Town, Yugawa Village, Yanaizu Town, Aizu Misato Town, Nishigo Village , Izumizaki Village, Nakajima Village, Yabuki Town, Tanagura Town, Yamatsuri Town, Hanawa Town, Samegawa Village, Ishikawa Town, Tamagawa Village, Hirata Village, Asakawa Town, Furudono Town, Miharu Town, Ono Town, Hirono Town, Shinchi Town, Tamura City, Minami Soma City, Kawamata Town And Kawauchi Village |
| Iwate Prefecture | Ichinoseki City, Oshu City, Hiraizumi Town |
| Miyagi Prefecture | Shiroishi City, Kakuda City, Kurihara City, Shichikashuku Town, Ogawara Town, Marumori Town, Watari Town, Yamamoto Town |
| Ibaraki Prefecture | Hitachi City, Tsuchiura City, Ryugasaki City, Joso City, Hitachiota City, Takahagi City, Kitaibaraki City, Toride City, Ushiku City, Tsukuba City, Hitachinaka City, Kashima City, Moriya City, Inashiki City, Hokota City, Tsukubamirai City, Tokai Village, Miho Village, Ami Town, Tone Town |
| Tochigi Prefecture | Sano City, Kanuma City, Nikko City, Otawara City, Yaita City, Nasushiobara City, Shioya Town, Nasu Town |
| Gunma Prefecture | Kiryu City, Numata City, Shibukawa City, Annaka City, Midori City, Shimonita Town, Nakanojo Town, Takayama Village, Higashiagatsuma Town, Kawaba Village |
| Saitama Prefecture | Misato City, Yoshikawa City |
| Chiba Prefecture | Matsudo City, Noda City, Sakura City, Kashiwa City, Nagareyama City, Abiko City, Kamagaya City, Inzai City, Shiroi City |

[66]Source: Ministry of the Environment (MOE), "Decontamination information site"
(the same source for Figure 1-22 to Figure 1-29)

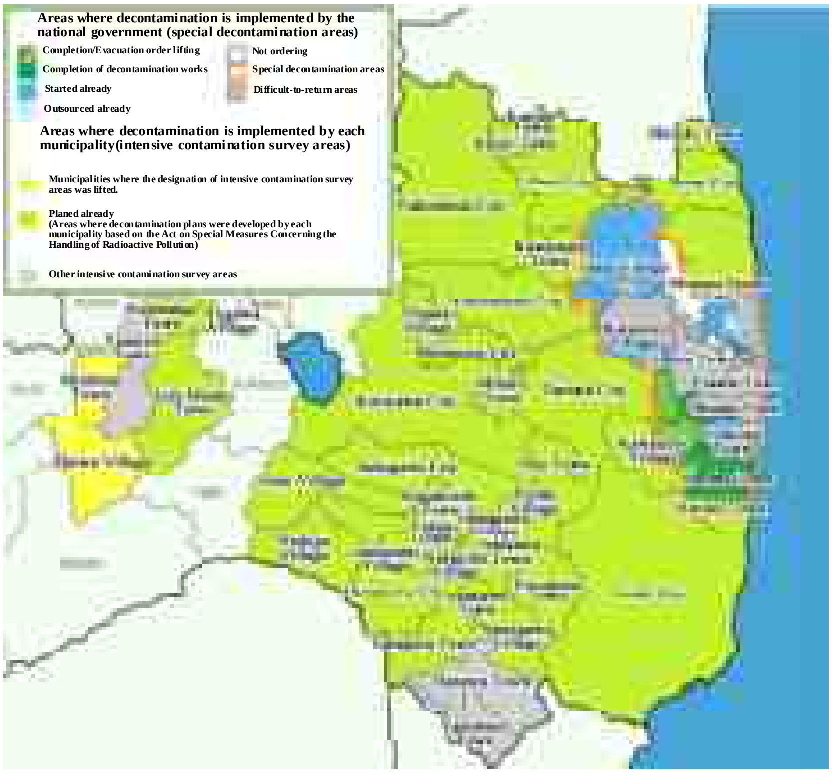



Figure 1-22 Designation status of Intensive Contamination Survey Area/ Special Decontamination Area and progress of decontamination works in Fukushima Prefecture.


Figure 1-23 Designation status of Intensive Contamination Survey Area and progress of decontamination works in Iwate Prefecture.


Figure 1-24 Designation status of Intensive Contamination Survey Area and progress of decontamination works in Miyagi Prefecture.

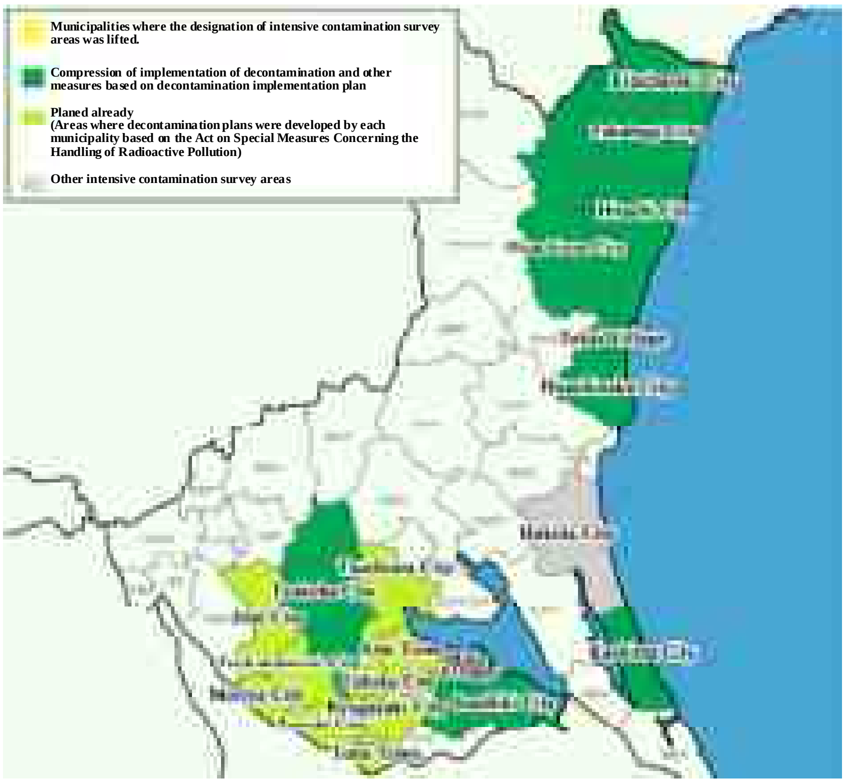



Figure 1-25 Designation status of Intensive Contamination Survey Area and progress of decontamination works in Ibaraki Prefecture.


Figure 1-26 Designation status of Intensive Contamination Survey Area and progress of decontamination works in Tochigi Prefecture.

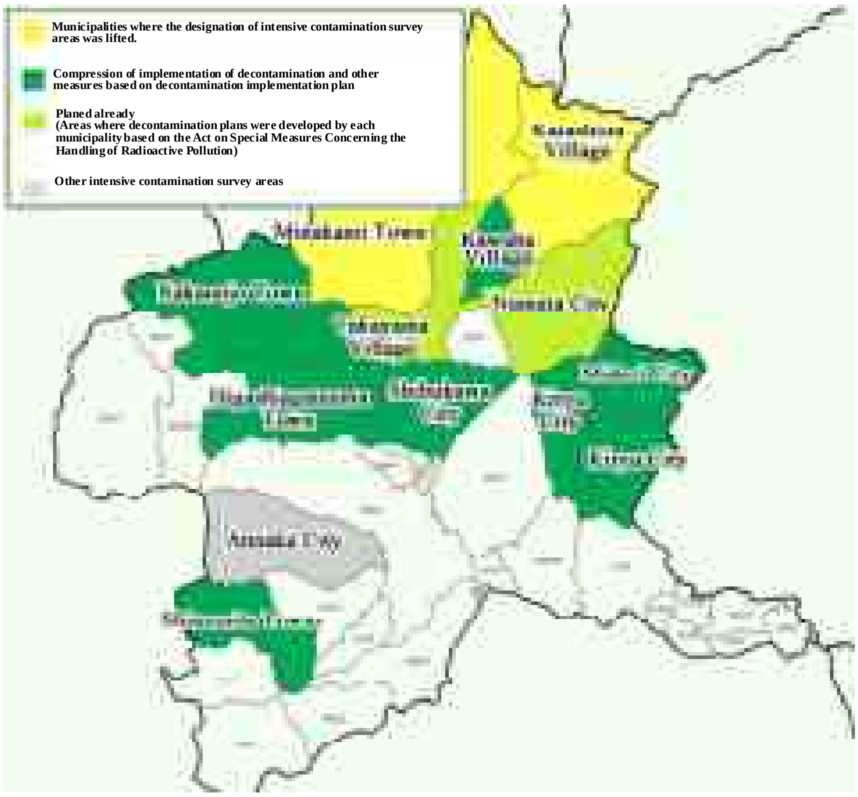



Figure 1-27 Designation status of Intensive Contamination Survey Area and progress of decontamination works in Gunma Prefecture.

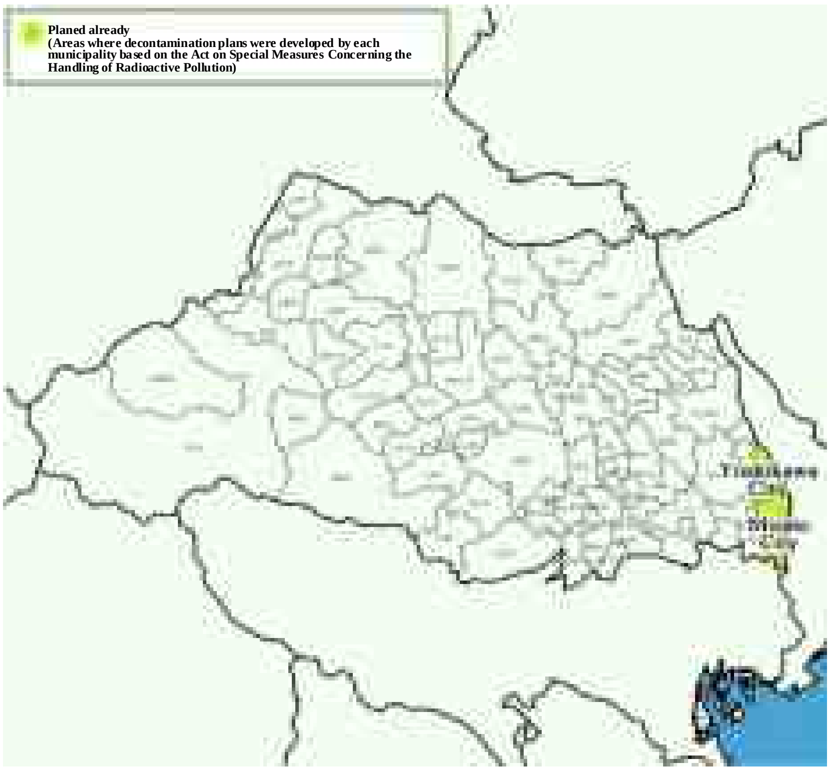



Figure 1-28 Designation status of Intensive Contamination Survey Area and progress of decontamination works in Saitama Prefecture.

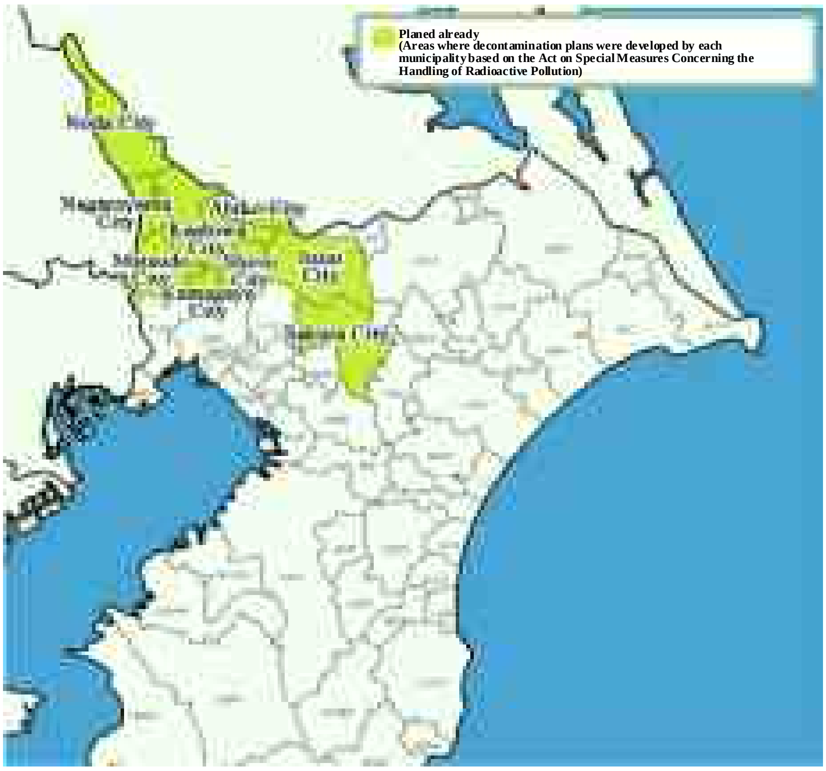



Figure 1-29 Designation status of Intensive Contamination Survey Area and progress of decontamination works in Chiba Prefecture.

## （3） Implementation system of decontamination works in Intensive Contamination Survey AreasIn Intensive Contamination Survey Areas, surveys and measurements of the contamination status are carried out first by the mayors and other officials of the municipalities with financial support by the National Government.

Based on the results of surveys and measurements, decontamination plans are developed by the mayors and others. In formulating the decontamination plan in each municipality, the consultation with the Minister of the Environment is done in advance. Through this consultation, determinations and recommendations are made about the adequacy of plan contents, and then planning is checked whether it corresponds to the works targeted for the budget support.

After the check has been completed, securing of temporary storage sites, reaching the consensus with stakeholders about the decontamination works, ordering of the decontamination works, implementing the decontamination works, and post-work investigation and verification are carried out sequentially by each municipality, in accordance with their own decontamination plan. All the costs for these works by each municipality are covered with the National Government financial support.

In addition, for the implementation of decontamination works in the target areas described in each municipality’s plan, it is prescribed in the Act on Special Measures that the National Government has the responsibility for the land under national control, and each prefecture has the responsibility for the land under its own control.

## （4） Progress in Intensive Contamination Survey Areas

Progress of implementation of the decontamination works and other measures in Intensive Contamination Survey Areas are described below for Fukushima Prefecture and other prefectures.

### 1）Fukushima Prefecture

Status of the ordering of decontamination works and the development of decontamination plans in Fukushima Prefecture is shown in Figure 1-30. Most ordering has been completed. However, for roads and forests (in the living space), the progress of their ordering is delayed.

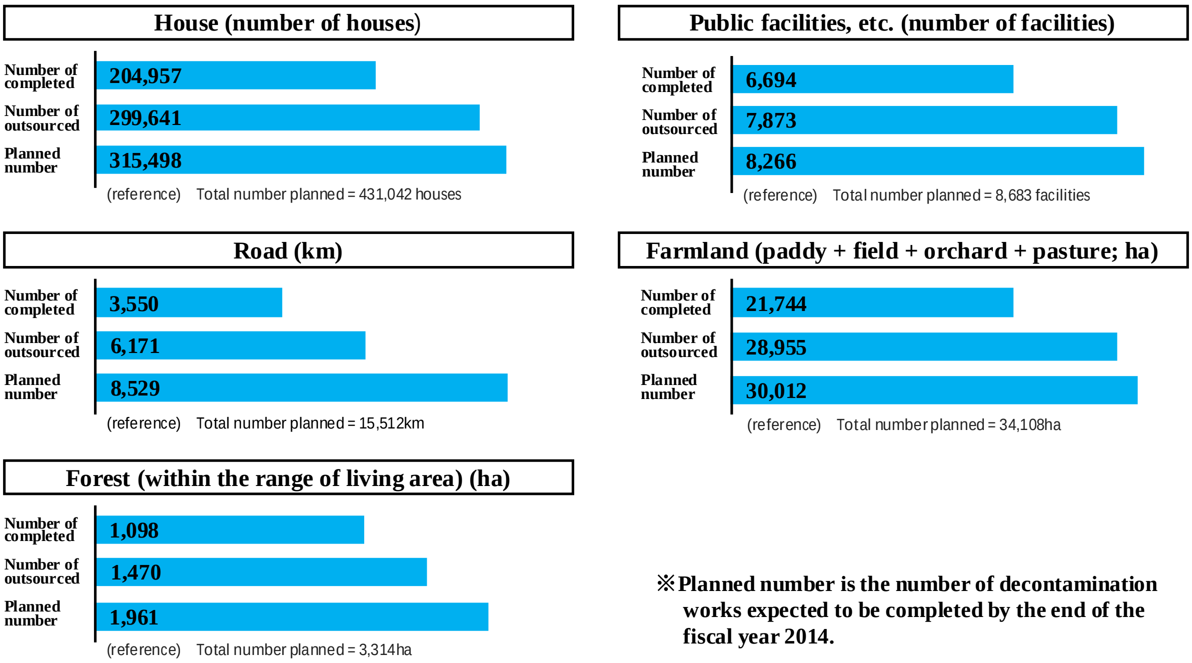



Figure 1-30 Progress of decontamination works in Intensive Contamination Survey Areas in Fukushima Prefecture (as of end of January 2015)[67].

## 2）Outside Fukushima Prefecture

Implementation status of decontamination and other measures in Iwate, Miyagi, Ibaraki, Tochigi, Gunma, Saitama and Chiba Prefectures is shown in Table 1-8 through Table 1-15.

The decontamination has already been completed or almost been completed in more than 70% of the municipalities.

Table 1-8 Completion status of implementation of decontamination and other measures based on decontamination implementation plans outside Fukushima Prefecture[68]

(as of end of December, 2014) (Number of municipalities)

| | (a)Completed | (b)Almost completed | (c)Continued | (d)Total |
|---|---|---|---|---|
| Iwate Prefecture | 0 | 2 | 1 | 3 |
| Miyagi Prefecture | 0 | 3 | 5 | 8 |
| Ibaraki Prefecture | 11 | 7 | 1 | 19 |
| Tochigi Prefecture | 0 | 4 | 4 | 8 |
| Gunma Prefecture | 7 | 1 | 1 | 9 |
| Saitama Prefecture | 0 | 2 | 0 | 2 |
| Chiba Prefecture | 0 | 8 | 1 | 9 |
| Total number | 17 | 26 | 15 | 58 |

[67]Source: Fukushima Prefecture, "Decontamination implementation status in decontamination areas (Intensive Contamination Survey Areas) in municipalities (February 27, 2015 update) " （https://www.pref.fukushima.lg.jp/site/portal/progress201501.html

[68]Source: Ministry of the Environment (MOE), "Compiled of progress survey results (as of end of December, 2014)" (February 13, 2015) (the same source for Table 1-9 to Table 1-15)

**Table 1-9 Progress of implementation of decontamination and other measures based on decontamination implementation plan outside Fukushima Prefecture (Schools and nursery schools, etc.)**

(as of end of December, 2014) (Number of facilities)

| | (a)Planned number | (b)Outsourced number | (c)Completed number | Number of unnecessary decontamination works in (a),(b) and (c) [the number that decontamination works were determined to be unnecessary by prior monitoring results] |
|---|---|---|---|---|
| Iwate Prefecture | 242 | 242 | 242 | (54) |
| Miyagi Prefecture | 95 | 95 | 94 | (10) |
| Ibaraki Prefecture | 329 | 329 | 329 | (42) |
| Tochigi Prefecture | 232 | 232 | 231 | (5) |
| Gunma Prefecture | 24 | 24 | 24 | (7) |
| Saitama Prefecture | 48 | 48 | 48 | 0 |
| Chiba Prefecture | 593 | 593 | 593 | (99) |
| Total number | 1,563 | 1,563 | 1,562 | (217) |

**Table 1-10 Progress of implementation of decontamination and other measures based on decontamination implementation plan outside Fukushima Prefecture (Parks and sports facilities)**

(as of end of December, 2014) (Number of facilities)

| | (a)Planned number | (b)Outsourced number | (c)Completed number | Number of unnecessary decontamination works in (a),(b) and (c) [the number that decontamination works were determined to be unnecessary by prior monitoring results] |
|---|---|---|---|---|
| Iwate Prefecture | 335 | 335 | 335 | (268) |
| Miyagi Prefecture | 153 | 150 | 149 | (56) |
| Ibaraki Prefecture | 888 | 887 | 887 | (335) |
| Tochigi Prefecture | 741 | 736 | 436 | (241) |
| Gunma Prefecture | 41 | 41 | 41 | (18) |
| Saitama Prefecture | 94 | 94 | 94 | 0 |
| Chiba Prefecture | 1,672 | 1,672 | 1,672 | (143) |
| Total number | 3,924 | 3,915 | 3,614 | (1,061) |

**Table 1-11 Progress of implementation of decontamination and other measures based on decontamination implementation plan outside Fukushima Prefecture (Housing)**

(as of end of December, 2014)　(Number of houses/buildings)

| | (a)Planned number | (b)Outsourced number | (c)Completed number | Number of unnecessary decontamination works in (a),(b) and (c) [the number that decontamination works were determined to be unnecessary by prior monitoring results] |
|---|---|---|---|---|
| Iwate Prefecture | 18,621 | 15,321 | 15,321 | (15,207) |
| Miyagi Prefecture | 10,228 | 8,503 | 7,350 | (2,972) |
| Ibaraki Prefecture | 47,276 | 47,276 | 47,266 | (45,143) |
| Tochigi Prefecture | 38,054 | 37,718 | 34,065 | (13,712) |
| Gunma Prefecture | 6,192 | 6,192 | 6,165 | (4,760) |
| Saitama Prefecture | 0 | 0 | 0 | 0 |
| Chiba Prefecture | 19,159 | 19,159 | 19,159 | (10,919) |
| Total number | 139,530 | 134,169 | 129,326 | (92,713) |

**Table 1-12 Progress of implementation of decontamination and other measures based on decontamination implementation plan outside Fukushima Prefecture (Other facilities)**

(as of end of December, 2014)　(Number of facilities)

| | (a)Planned number | (b)Outsourced number | (c)Completed number | Number of unnecessary decontamination works in (a),(b) and (c) [the number that decontamination works were determined to be unnecessary by prior monitoring results] |
|---|---|---|---|---|
| Iwate Prefecture | 3,098 | 2,577 | 2,577 | (2,445) |
| Miyagi Prefecture | 348 | 348 | 332 | (180) |
| Ibaraki Prefecture | 634 | 634 | 634 | (543) |
| Tochigi Prefecture | 402 | 353 | 223 | (136) |
| Gunma Prefecture | 123 | 122 | 122 | (86) |
| Saitama Prefecture | 8 | 8 | 8 | 0 |
| Chiba Prefecture | 227 | 227 | 227 | (130) |
| Total number | 4,840 | 4,270 | 4,124 | (3,520) |

Table 1-13 Progress of implementation of decontamination and other measures based on decontamination implementation plan outside Fukushima Prefecture (Roads)

(as of end of December, 2014) (m)

| | (a)Planned number | (b)Outsourced number | (c)Completed number | Number of unnecessary decontamination works in (a),(b) and (c) [the number that decontamination works were determined to be unnecessary by prior monitoring results] |
|---|---|---|---|---|
| Iwate Prefecture | 2,151,600 | 2,140,600 | 2,140,600 | (2,140,400) |
| Miyagi Prefecture | 332,409 | 73,232 | 73,232 | (32,726) |
| Ibaraki Prefecture | 1,164,205 | 1,120,705 | 1,120,705 | (1,117,240) |
| Tochigi Prefecture | 81,402 | 81,402 | 81,402 | (76,875) |
| Gunma Prefecture | 203,378 | 203,378 | 203,378 | (201,502) |
| Saitama Prefecture | 3,409 | 3,409 | 3,409 | 0 |
| Chiba Prefecture | 232,874 | 232,874 | 232,874 | (137,388) |
| Total number | 4,169,277 | 3,855,600 | 3,855,600 | (3,706,131) |

Table 1-14 Progress of implementation of decontamination and other measures based on decontamination implementation plan outside Fukushima Prefecture (Farmland and pastures)

(as of end of December, 2014) ($m^2$)

| | (a)Planned number | (b)Outsourced number | (c)Completed number | Number of unnecessary decontamination works in (a),(b) and (c) [the number that decontamination works were determined to be unnecessary by prior monitoring results] |
|---|---|---|---|---|
| Iwate Prefecture | 0 | 0 | 0 | 0 |
| Miyagi Prefecture | 557,000 | 557,000 | 217,000 | 0 |
| Ibaraki Prefecture | 0 | 0 | 0 | 0 |
| Tochigi Prefecture | 12,278,300 | 12,278,300 | 12,142,000 | (3,755,900) |
| Gunma Prefecture | 1,043,597 | 1,043,597 | 1,043,597 | (951,708) |
| Saitama Prefecture | 0 | 0 | 0 | 0 |
| Chiba Prefecture | 0 | 0 | 0 | 0 |
| Total number | 13,878,997 | 13,878,897 | 13,402,597 | (4,707,608) |

**Table 1-15 Progress of implementation of decontamination and other measures based on decontamination implementation plan outside Fukushima Prefecture (Forests (Nearby living areas))**

(as of end of December, 2014) ($m^2$)

| | (a)Planned number | (b)Outsourced number | (c)Completed number | Number of unnecessary decontamination works in (a),(b) and (c) [the number that decontamination works were determined to be unnecessary by prior monitoring results] |
|---|---|---|---|---|
| Iwate Prefecture | 0 | 0 | 0 | 0 |
| Miyagi Prefecture | 2,000,000 | 2,000,000 | 1,029,709 | (185,355) |
| Ibaraki Prefecture | 7,186 | 7,186 | 7,186 | 0 |
| Tochigi Prefecture | 831,760 | 831,760 | 831,760 | 0 |
| Gunma Prefecture | 60,155 | 54,555 | 53,755 | (38,563) |
| Saitama Prefecture | 0 | 0 | 0 | 0 |
| Chiba Prefecture | 0 | 0 | 0 | 0 |
| Total number | 2,899,101 | 2,893,501 | 1,922,410 | (223,918) |

## 1.2. Features of contamination

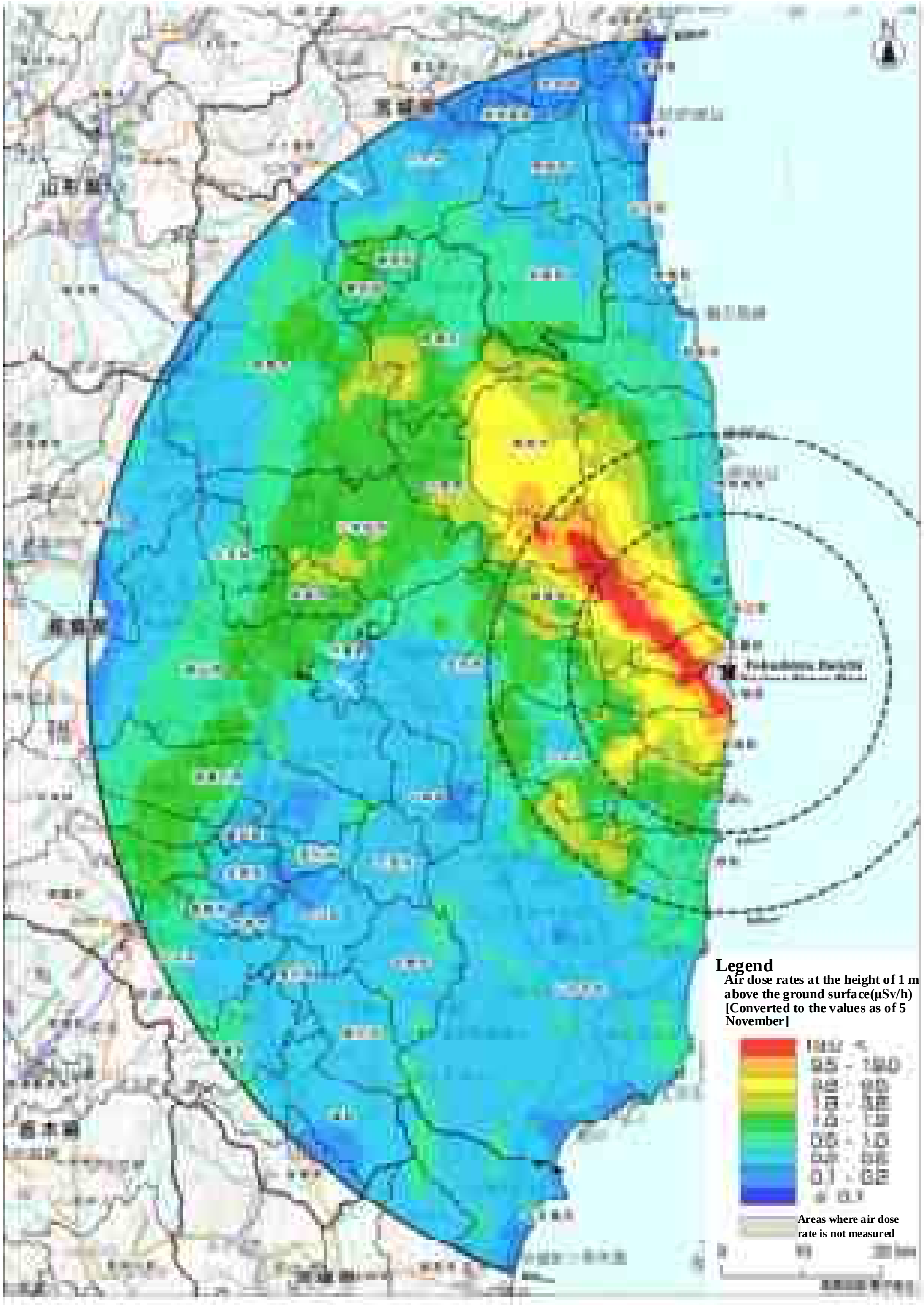
### 1.2.1. Dispersion status of radioactive materials

Radioactive materials were discharged from the damaged nuclear reactors at the 1FNPS. The total amount of radioactive materials discharged in the period between March 11 and April 5, 2011, was estimated to be approximately $1.5 \times 10^{17}$ Bq for iodine-131 and approximately $1.3 \times 10^{16}$ Bq for cesium-137 (estimated based on the data of environmental monitoring, etc. using an atmospheric dispersion factor)[69]. A massive amount of radioactive materials was dispersed into the atmosphere.

The results of various monitoring surveys confirmed that radioactive materials had dispersed into wide areas, not only into the evacuated areas but also into areas outside those defined as evacuation areas, as a result of the accident, as mentioned in 1.1.2. For reference, Figure 1-31 shows the result of a monitoring survey which was done using an aircraft by the MEXT during the period between October 22 and November 5, 2011. As understood when compared with the evacuation area shown in Figure 1-13, contamination was confirmed not only in the areas to which an evacuation order was made (and residents were no longer present), but also in the areas with residents present. The dose reduction activities were needed in such areas.

Because radioactive materials move over time as they are carried by rainfall and other factors and the ease of accumulation varies by place, depending on the shape and material of structural objects, the dose distribution had become uneven over time compared to the condition immediately after the accident, and there occurred some localized high-dose points called hot spots (Figure 1-33). Such unevenly contaminated conditions in micro and macro terms led to a difference in decontamination methods by areas and buildings and accordingly caused concerns of the residents about the existence of high radiation sources in nearby areas, as well as affecting their sense of fairness for the level of decontamination by area and house. Detailed explanations and appropriate responses were required to address these issues.

[69] Source: JAEA, "Summary of Estimation of Release Amounts of $^{131}I$ and $^{137}Cs$ Accidentally Discharged from Fukushima Daiichi Nuclear Power Plant into the Atmosphere" (May 12, 2011)




* Air dose rate due to natural radionuclides is included in this map.

Figure 1-31 Result of the Fourth Airborne Monitoring Survey (October to November 2011) by MEXT (Air dose rates at the height of 1 m above the ground surface within an 80 km zone from the 1FNPS)[70].

[70]Source: Ministry of Education, Culture, Sports, Science and Technology (MEXT), "Result of the Fourth Airborne Monitoring Survey by MEXT" (December 16, 2011) (the same source for Figure 1-32)

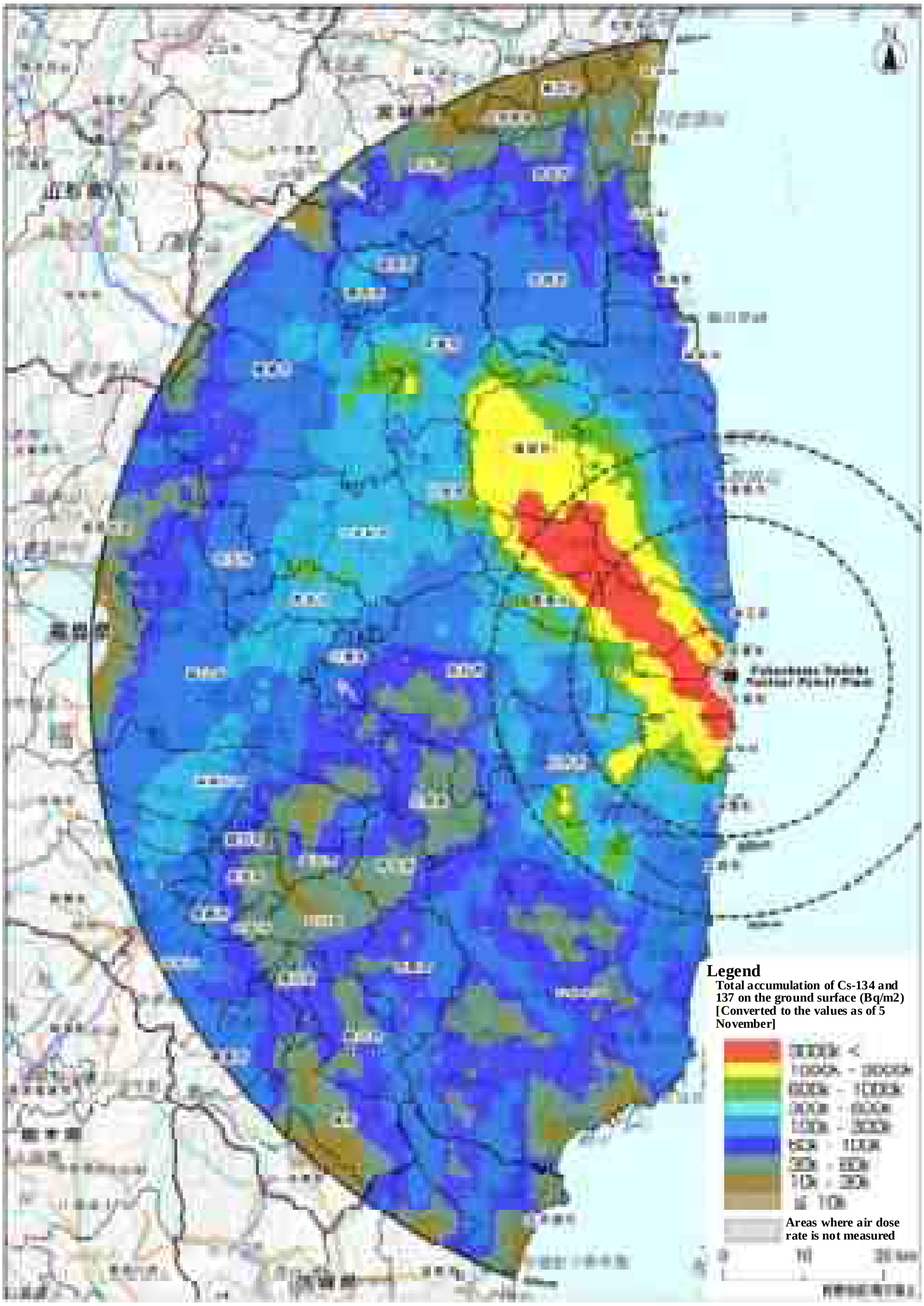
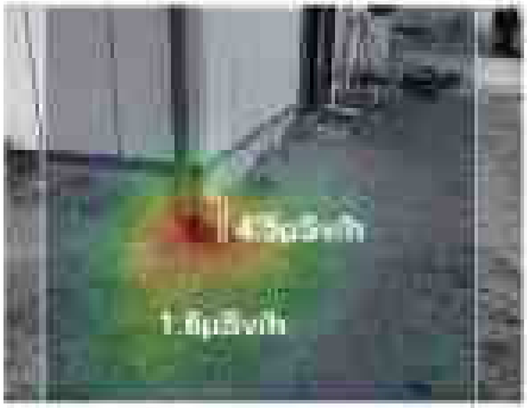



Figure 1-32 Result of the Fourth Airborne Monitoring Survey (October to November 2011) by MEXT (Total accumulation of $^{134}Cs$ and $^{137}Cs$ on the ground surface within an 80 km zone from the 1FNPS).

**Aizubange Town**


**Place where rainwater flows and drops**




**Bottom of downspout**

**Onami district, Fukushima-City**

**Exit of downspout**


**Place where rainwater flows**

**Figure 1-33 Monitoring of contamination status with gamma camera images at the hotspot locations[71].**

### 1.2.2. Major nuclides

Released radioactive materials included xenon-133, tellurium-132, strontium and plutonium in addition to cesium and iodine.

Among them, strontium and plutonium were monitored from June 6 through June 14 and from June 27 through July 8, 2011 by the MEXT). As a result, plutonium-238 and plutonium-(239+240) were detected in the northwest direction within the radius of 45 km from TEPCO's 1FNPS, as shown in Figure 1-34. However, the amount was within the monitoring level of the deposition quantity of plutonium due to atmospheric nuclear tests which had been monitored nationwide for 11 years before the accident, except for one place (1.4 times of the maximum amount of plutonium monitored before the accident). Relatively high amount of strontium-89 and -90 has also been monitored on the ground surface in the northwest direction from the 1FNPS. However, those quantities indicated a tendency to decrease as the distance got away from the power station. Based on these measurements, cumulative effective doses of 50 years were calculated for every radionuclide which was deposited on the soil. As a result of these analyses, it was confirmed that the

[71]Source: "Discussion meeting with well-informed persons about decontamination ~ Considering future from the former knowledge in National Government and 4 cities ~ Fact book" (June 20, 2014 edition)(http://josen.env.go.jp/material/pdf/session_140615/session_140615_03_140620.pdf)

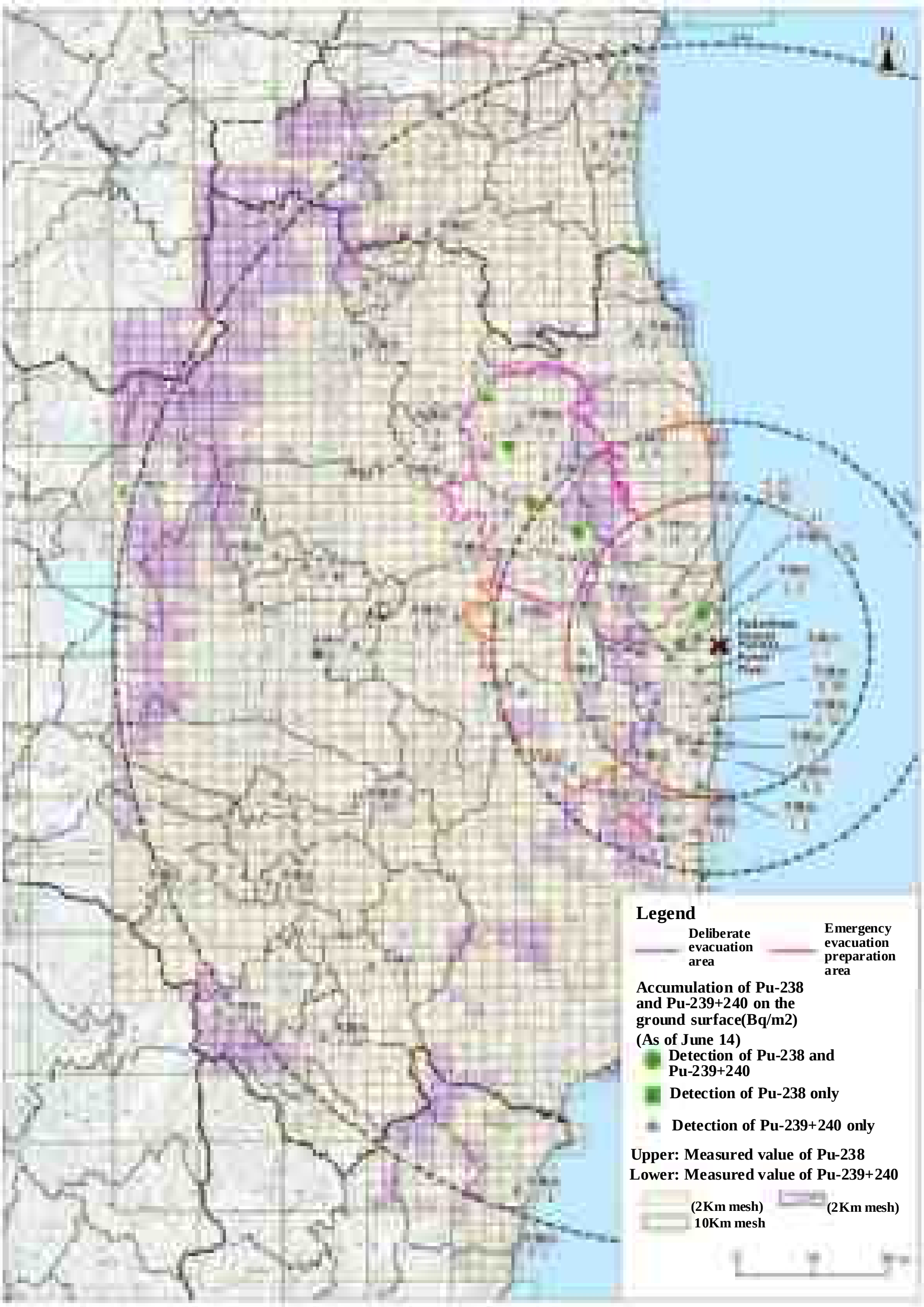
influences of radiation exposure due to the nuclides other than radioactive cesium are very small compared with those of radioactive cesium that was released in large quantities[72].

Furthermore, as the half-lives of iodine 131, Xenon 133 and tellurium 132 are short with approximately eight days, five days and three days, respectively, the influence of radioactive exposure due to these nuclides becomes small after the early days of the accident. Therefore when considering person's radiation exposure at present, important nuclides have become two of cesium 134 (half-life; about 2.1 years) and cesium 137 (half-life; about 30.2 years).

[72]According to the "Results of nuclide analyses of plutonium and strontium by the Ministry of Education, Culture, Sports, Science and Technology (MEXT)", those are as follows. Cumulative effective doses of 50 years have been analyzed in each place where the highest values were detected in the deposition amounts of plutonium-238, plutonium-(239+240), and strontium-89 and -90. For them, plutonium-238 was 0.027 mSv, plutonium-(239+240) was 0.12 mSv. Strontium-89 was 0.61μSv (0.00061 mSv), and strontium-90 was 0.12 mSv.

On the other hand, those values of cesium-134 and -137 were 71mSv and 2.0Sv (2,000mSv), respectively, in each place where the highest values were detected for the deposition amounts of cesium-134 and -137.

In addition, in these analyses, the effect of dose reduction by decontamination is not included, and it is assumed to have stayed the same at the same place for 50 years.




Places where plutonium 238 and 239+240 are considered to have been deposited newly due to the accident of Fukushima Daiichi nuclear power plant

Figure 1-34 Measurement results of $^{238}Pu$ and $^{239+240}Pu$ on the ground surface[73].

[73]Source: Ministry of Education, Culture, Sports, Science and Technology (MEXT), "Results of nuclide analyses of plutonium and strontium by the Ministry of Education, Culture, Sports, Science and Technology (MEXT)" (September 30, 2011) (the same source for Figure 1-36)

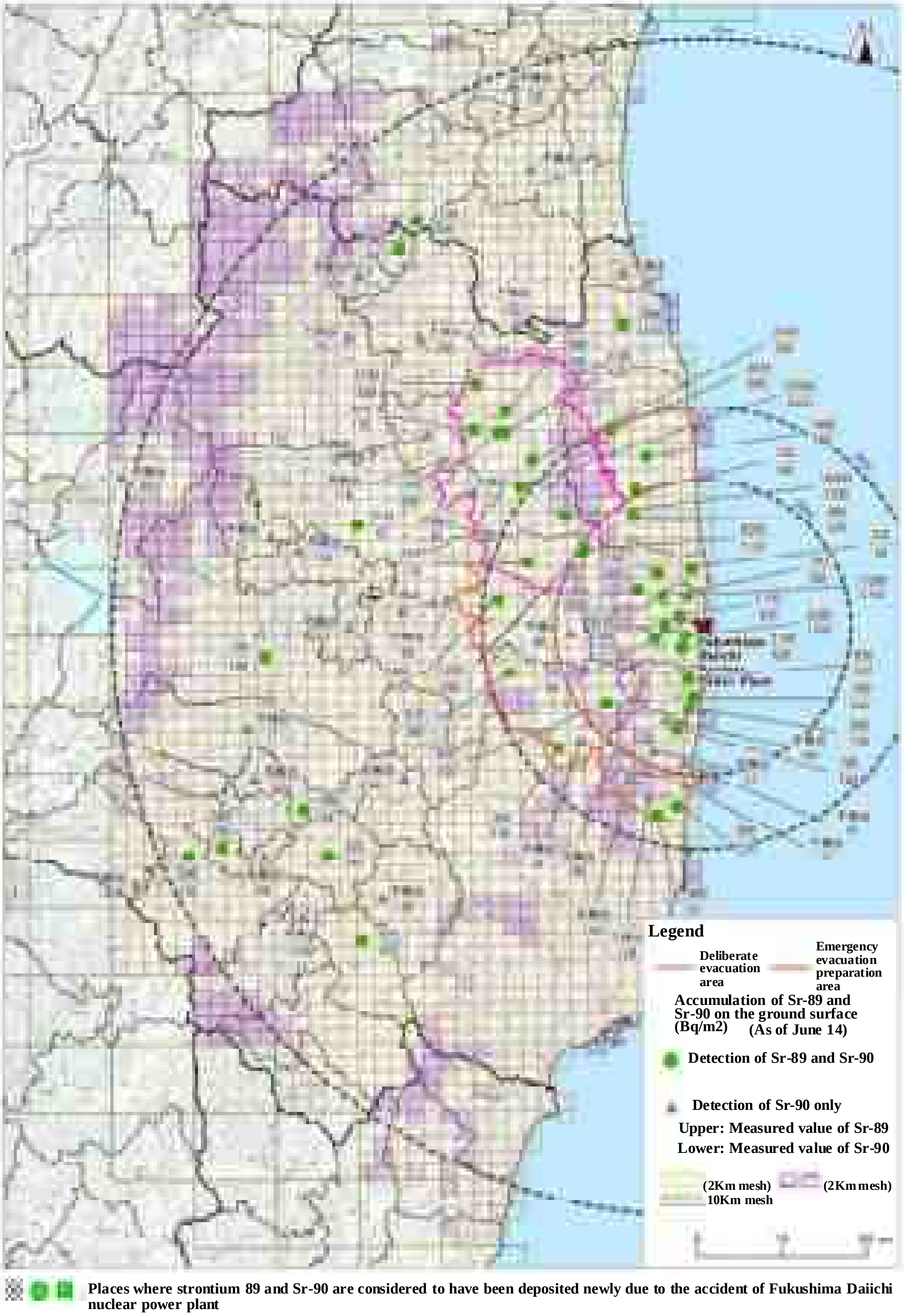



Figure 1-35 Measurement results of $^{89}Sr$ and $^{90}Sr$ on the ground surface.

## 1.3. Features of decontamination

### 1.3.1. Unprecedented large-scale decontamination activities

Since radioactive materials have been dispersed across a wide area, decontamination works in Japan associated with the accident at the 1FNPS have to be done in vast areas as indicated in 1.1.2 and 1.1.3: it is an extremely large-scale project that has not been seen before. We are also required to promote large-scale decontamination projects that no one has ever done before, while obtaining the consents of related persons, such as owners of residential land. Moreover, we faced a large number of problems, as we did not have enough time for planning. To solve these problems, various measures were taken and considerable efforts were made.

#### （1） Establishment of strategic decontamination process

#### 1）Implementation of large-scale decontamination with strategic decontamination process

The areas subjected to decontamination are extremely broad. There are several tens of thousands to hundreds of thousands of residential land lots from which it is necessary to obtain consent, which means the number of involved persons such as owners is enormous and a great amount of time and manpower is required to obtain their consent. Therefore, it is not necessarily efficient to hastily start a large amount of decontamination works at one time before putting in place the system for decontamination.

To address such a situation, we implemented the “Demonstration model project for decontamination” especially in the Special Decontamination Areas where the residents had been evacuated and no restored infrastructures had been put in place. Through decontaminating local government offices and public facilities first, while confirming and accumulating achievements and technical knowledge, we formed bases for decontamination and restoration/reconstruction works, which led to smooth large-scale decontamination (full-scale decontamination) works later.

In the full-scale decontamination, the strategic efforts by building bases were seen as with the case of preliminary decontamination: these efforts were intended to increase the speed of decontamination works as much as possible and improve the workplace safety of the workers by first decontaminating the workers’ base for taking a rest.

#### 2）Decontamination plan based on the weather

The weather varies greatly from season to season in Japan.

The demonstration model project for decontamination has proved that especially in winter it is difficult to get accurate values of air dose rate due to the shielding effect of falling and accumulated snow and there is a reduction in decontamination efficiency, increase in weight and volume of waste due to the attachment of snow and problems in using cars, etc., as indicated in 1.1.6 (7). Therefore, it has become a general rule not to perform decontamination forcedly during the time of snowfall and accumulation in the full-scale decontamination.

Also, in the rainy and typhoon seasons, there are many concerns, including those for measuring error, outflow of materials removed by decontamination, problems in recovering decontamination waste water and concerns about worsening of the labor environment for decontamination workers. Therefore, we make it a rule to stop the decontamination works under certain conditions of wind and rain.

Because we sometimes need to postpone the schedule of decontamination due to weather conditions, we need to plan work schedules taking into account these impacts.

Although high temperature and solar insulation in summer do not affect the decontamination work itself, they may result in a harsh working environment and have impacts on the health of decontamination workers. To address such a situation, we decided to work on decontamination with due considerations for prevention of heat stroke and response to sudden illness depending on the weather, including wearing of protective clothing with cold packs and avoidance of working during hours when temperatures are the highest, as well as raising the awareness of workers about heat stroke.

## （2） Securing decontamination workers

### 1）Securing the quantity of decontamination workers

While the decontamination work does not necessarily require a high level of skill, it has to be done with consideration for the level of radiation dose and conditions of the decontamination objectives. Also, only a very limited part can be done by machine. As a result, we need a large number of workers: the numbers of local workers that can be employed are not sufficient to secure the required number of decontamination workers, and we needed to recruit widely from outside Fukushima Prefecture.

However, the Great East Japan Earthquake which sled to the accident at the nuclear power station, inflicted massive damage on the Tohoku region, mainly to Miyagi, Iwate and Fukushima Prefectures as mentioned in 1.1.2 There have been large-scale restoration/reconstruction projects after the earthquake underway in Miyagi and Iwate Prefectures, and there has been a great demand for construction workers doing decontamination and other works also in the prefectures other than Fukushima. Therefore, it has been very difficult to secure the required number of decontamination workers.

Furthermore, many workers were required for works to be done on the site of the 1FNPS, which added to the difficulty to secure the necessary number of decontamination workers.

Therefore, the MOE and local governments have worked to reduce concerns for becoming a decontamination worker, by introducing the details of decontamination work in an easy-to-understand way. In addition, they tried to secure decontamination workers by implementing various measures, including payment of a special allowance in the Special Decontamination Areas.

### 2）Securing the quality of decontamination workers

Although decontamination work does not necessarily require a high level of skill, sufficient effects may not be obtained if workers do not know the principle of decontamination and do not follow a certain procedure. Moreover, since radiation is not visible unlike ordinary contamination and dust, it has the feature that we cannot tell whether a sufficient decontamination effect is obtained or not without measurement. If appropriate decontamination work is not done, it could lead to not only an increase of removed substances, but also problems with residents. Therefore, securing the quality, as well as the quantity, was required in recruiting decontamination workers.

On the other hand, it was difficult to secure a large number of workers who had knowledge and experience in decontamination and radiation from the outset, because general citizens were not familiar with the knowledge of radiation, let alone decontamination, in Japan before the Great East Japan Earthquake as mentioned in 1.1.1 Therefore, we had no choice but to nurture the knowledge of decontamination through education. The efforts were made to provide many workers with education about decontamination. For example, decontamination business operators provided the special education and the newcomer education based on the Ionizing Radiation Ordinance for decontamination to workers before starting decontamination work, as well as regular education and training on safety. They also implemented accident prevention activities and mutual checking of radiation protection measures among workers on the site of work every morning before starting decontamination work. In addition to the above, they themselves extracted and presented example cases of successes and failures at work sites. The MHLW transmitted animated materials for special education about decontamination on YouTube and Fukushima Prefecture and MOE held training sessions on decontamination work for decontamination workers and site supervisors. These efforts helped decontamination business operators perform educational activities more smoothly and easily.

Furthermore, decontamination workers are required to be of sufficient quality in terms of consideration to related persons and local residents as shown in 1.3.3, as well as in terms of knowledge about decontamination. Especially, those from outside the decontamination area were required to exhibit behavior and awareness worthy of getting the trust of related persons and residents.

Moreover, the work of decontamination is unlikely to give a sense of accomplishment to workers, unlike civil engineering work and construction which are actions of making structural objects. A high level of patience is also required for decontamination workers to continue the work without degrading its quality, because they have to continue relatively monotonous work of decontamination endlessly while placing extra effort on radiation protection. Therefore, how to maintain the motivation of the workers was a critical issue.

The workers from the disaster-affected areas could maintain their motivation when they saw the improved appearance as a result of their work such as mowing and they could feel their hometowns were being restored. However, it is not always true for the workers from outside the areas. To maintain and secure their motivation, various efforts were made, including making repetitive communications about what their efforts would bring about, showing the effects of their work by comparing the data before and after decontamination, and conveying voices of appreciation and encouragement from the local people.

### （3） Preparation of project environment

To perform this great amount of unprecedented decontamination work, it is also important to prepare uniform procedures and systems to order and perform the work smoothly as a project, as well as the strategic process as shown in (1) above and the securing of the quantity and quality of workers as shown in (2) above.

Since there were a limited number of personnel at the MOE who had the experience of implementing public works as a direct control project, they used the existing rules and systems that had been established by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and the MAFF, while obtaining help from personnel of the two ministries who had many experiences of doing such works. Thus, the MOE temporarily created the common specifications and other rules (hereinafter referred to as the “Common Specifications”) that were required to implement the decontamination and other construction works as a direct control project by searching for a way and starting the decontamination work. After that, they continued to improve the specifications step-by-step according to the actual conditions of the decontamination sites through a trial and error process. As a result of these efforts, they established the rules from the framework of the entire decontamination work to specific construction work implementation methods to a certain extent to enable a quick start of the decontamination works. They also strove to ensure the quality of works.

On the other hand, while we can create design documents for conventional civil engineering work in advance, we have to place an order based on approximate figures for decontamination, because orders are placed before consent forms are collected. Therefore, we needed to agree on a construction unit price in advance so that we could adjust an account after implementing decontamination work.

Also, although we need to provide documents about unit price for each decontamination objective at the time of placing an order, it was difficult to accurately determine the unit prices[74] in advance. Therefore, we estimated the unit prices to allow quick order placement by setting up a team, which included staff members from the MLIT and the MAFF who had many experiences in placing orders for civil engineering work, based on the results of decontamination that had been implemented independently under the model project of the Cabinet Office, as well as by Fukushima Prefecture and municipalities. The situation assumed under the model project may not always apply to the actual sites of decontamination, because there are different conditions such as the existence of newly growing trees after the earthquake. Therefore, we promoted a PDCA (Plan-Do-Check-Act) cycle energetically, through changing actual work depending on the condition of the site and providing feedback about the results. There were also some cases in which we had to do work on the site that had not been specified in the decontamination guidelines or the Common Specifications. In such cases, the work was done through trial and error and discussions between the supervising officials from the National Government and the decontamination business operators. Such knowledge was shared among the supervising officials to be reflected in the Common Specifications and other documents when appropriate.

If we try to respond easily to the request of related persons, it may cause a risk of excessive decontamination. The excessive decontamination would increase the total amount of removed

[74]Unit price represents a quantified amount of time and effort that is required for a certain task.

materials, as well as cause a feeling of unfairness among other related persons. To prevent these problems, we standardized the judgment on reasonableness for the entire project, and included it as a new rule in the standard procedures, if it could be theorized or generalized to ensure consistency.

In addition, the National Government improved the environment for decontamination work on the site, as well as created a good project environment by preparing documents. For example, there is a concern that the amount of daily life waste disposal and sewage treatment might exceed the existing disposal/treatment capacity, as a result of a significant number of workers being expected to come from other local communities and prefectures. We worked to avoid such a shortage of treatment capacity by ensuring exchange and confirmation of information between the National Government and local governments in advance, without fully leaving the response to decontamination business operators.

### 1.3.2. Decontamination to secure safety at an early stage and to facilitate restoration and reconstruction

#### （1） Acceleration of project through sharing information and promoting PDCA cycle

Since early stage securing of safety and restoration/reconstruction was required, we had to start the decontamination project without sufficient lead-time for conducting sufficient policy preparation. Therefore, we focused on the PDCA cycle and incorporated information that had not been prepared or known in the preparation stage moment to moment to compensate for the lack of time at the preparation stage. A part of such efforts is mentioned in Section 1.3.1.(3).

In large-scale decontamination works that are performed in multiple municipalities, implementation of an individual PDCA cycle only may cause isolated optimization. The system for information sharing is critical for implementing a PDCA cycle that can contribute to the optimization of decontamination work as a whole. The governmental organizations that played a central role in the information sharing were the Fukushima Environment Restoration Office for Fukushima Prefecture, Iwate Prefecture and Miyagi Prefecture, and the Kanto Region Environment Office for Tochigi Prefecture, Ibaraki Prefecture, Gunma Prefecture, Chiba Prefecture and Saitama Prefecture.

#### （2） Improvement of decontamination speed through setting up of temporary storage sites

In order to perform decontamination work smoothly, it is desirable to secure a disposal site for removed soil and other materials generated by decontamination work before starting actual work. There is a limited amount of large land space in Japan that may be used immediately as shown in 1.1.1. If we started decontamination work after we had secured disposal sites for significant amounts of removed soils and other materials, it would take much time and it was clear that the start of decontamination would be delayed.

To solve this problem, we decided to secure so called “temporary storage sites” used to store removed soils and materials temporarily before bringing them to the disposal facility (interim storage facility), to promote the decontamination work, while making efforts to secure the disposal facility.

However, there were many cases in which the setting up of a temporary storage site was not decided easily due to a limited amount of land. Many different efforts were made to set up temporary storage sites.

The reasons why the setting up of temporary storage sites was not advanced easily include the following.

- Difficulty of setting up sites on public lands
  - ✓ There were sufficient areas of national forests[75], and it was not so difficult to form a consensus about making national forests as candidate sites for temporary storage. However, many such forests were preserved as protected forests under the Forest

[75] The area of national forests in Fukushima Prefecture amounts to approximately 400 thousand ha, while the entire area of Fukushima Prefecture is approximately 1 million 400 thousand ha.

Act and the procedures for cancellation of protected forests were required. It took much time to conduct studies and perform cancellation procedures.
- ✓ Since the national forests are located in mountainous areas, we need land reclamation to make them flat. In addition, there are some cases in which preparation and improvement of access roads are required and the disposal of soil from such work also has to be stored. As a result, we could not utilize the area of reclaimed land effectively, and it resulted in taking much time for land reclamation, etc.

- Difficulty in forming consensus with residents living in the vicinity
  - ✓ The residents became angry and felt frustrated, because temporary storage sites were set up not on the premises of TEPCO or national land, but on sites in the vicinity of the residents who were suffering from evacuation and anxieties from radiation. That became a major obstacle to the formation of consensus.
  - ✓ The residents were worried that the temporary storage site might become a final disposal site.
  - ✓ There was a concern that accumulation of soil contaminated with radioactive materials might enhance the impact of radiation.
  - ✓ Residents had a feeling of rejection of storing even contaminated materials that were generated outside their own lands.

To address such problems, the National Government, municipalities and decontamination business operators advanced the following efforts, which led to dispelling the concerns and setting up temporary storage sites by municipalities.

- Seeking candidate lands in the local area
  - ✓ In the case where it was difficult to secure an appropriate temporary storage site within the national land, this fact was communicated honestly to the municipal governments and residents and understanding for securing a temporary storage site in the region was requested. We worked to seek practical solutions jointly with the local community.

- Elimination and mitigation of concerns and frustrations
  - ✓ In response to the opinions that the temporary storage site should be set up within the premises of TEPCO and the national land, we did not turn down such opinions immediately, but explained that it was not practical when looking at it objectively, after considering the practicality of using each premise, and requesting and negotiating with other governmental agencies in some cases. We also worked to eliminate and mitigate frustrations of the residents by making an in-depth explanation that to secure the site in their community would result in advancing decontamination more quickly.
  - ✓ In response to the concerns about the safety of the temporary storage site, we made the following explanations to eliminate and mitigate concerns of the residents: the outmost part would be covered by uncontaminated soil; and accumulated soils would have lower risk once they were accumulated and sufficient safety measures were taken compared to the case in which removed soil was stored on the site.
  - ✓ In addition, there was also an effort to help the residents realize the safety of a temporary storage site through their building a system for monitoring the temporary storage site as in the case of Kawamata Town.
  - ✓ In response to the feeling of rejection of storing contaminated materials that were generated outside their own lands, we explained patiently that setting up the facility would result in advancing decontamination more quickly. Also, we sought the cooperation of heads of district and neighborhood associations, who were closer

to the residents in terms of psychological distance, and asked them to consider setting up a temporary storage site in each administrative district.
  - ✓ In the case of Fukushima Prefecture, in response to the concerns that the temporary storage site might become a disposal facility eventually, the MOE was in the forefront of the efforts to prepare for interim storage facilities as much as possible and to appeal with such an attitude to eliminate and mitigate concerns of the residents.

- Transmission of information on actual status
  - ✓ Since the residents did not have an image of a temporary storage site especially in the initial stage, we worked to create a concrete image of the facility, by providing explanations with leaflets and holding tours on the site of a temporary storage site that was actually set up, in order to reduce psychological resistance against the facility.
  - ✓ Since decontamination work advanced quickly in the areas where the temporary storage site was set up, we made appeals with such results to make the residents recognize the necessity and the importance of the temporary storage site, in order to accelerate the setting up of a temporary storage site also in the areas where the facility had not been set up.

- Flexible response appropriate for the situation of each area
  - ✓ When it was difficult to set up a temporary storage site by any means, we responded in a flexible way according to the situation of each area, such as operation with storage of removed soil and materials on the site, and not sticking to setting up the temporary storage site as an absolute requirement.

Furthermore, we reduced the amount of generated removed soil and materials through avoiding excessive decontamination as mentioned above in the first place in order to reduce the amount of removed soil and materials that were to be brought into the temporary storage site. We also reduced the volume of removed soil and materials by cutting, crushing, compressing or burning them.

### 1.3.3. Project operation with consideration of the maintenance of community and the protection of rights

#### （1） Maintenance of community

This decontamination project derived from the 1FNPS accident focused on residents' returning to their previous lives as early as possible. Therefore, we were required to promote it without damaging the local communities to ensure later life there, not just to remove contaminated soil and materials.

To achieve this goal, we employed a method to perform decontamination work by an administrative unit, such as a district; that is to say "Decontamination of the entire community," not to advance decontamination work for each related person after obtaining the consent. This decontamination method has a disadvantage for the residents who agreed on performing decontamination work earlier, because it starts after obtaining the consent from all the residents of an administrative unit, such as the district.

Despite such a disadvantage, we needed to promote decontamination work focusing on the local communities that had already existed, given the healthy maintenance of each community after decontamination, in addition to the fact that there was no sufficient decontamination result without decontamination for the whole area.

As to setting up the temporary storage site as shown in Section 1.3.2.(2), many residents said that they agreed to accept the removed contaminated soil from inside their community, but not those from other communities. It can be said that the unit of the local community, such as a district, was one of the important units in Japan to advance decontamination.

This concept was also used in setting evacuation areas. In order to avoid separation of a local community or district, we did not use the annual exposed dose as sole criteria for setting a border of an evacuation area. We were careful so that the border of an evacuation area did not divide a district unit, while making the exposure dose the fundamental criterion.

## （2） Protection of rights and consideration of lifestyle

This decontamination project focused on residents' returning to their previous lives as early as possible. Therefore, we did a minimum amount of scraping and replacement of roof materials so as to avoid damages to properties owned by the residents as much as possible. In the case of the residents engaged in farming, the agricultural land was inseparable from their lives: they had cultivated and nurtured their land over a long period of time. Therefore, when a farming family requested it, we tried to select an appropriate decontamination method as much as possible to avoid stripping, etc. and worked to maintain the functions of agricultural soils.

Some residents said, "I want a full replacement." We patiently provided explanations and were committed to protect their properties and agricultural lands that were very important for farming households.

Also, ancestral shrines and garden trees they had grown over years were irreplaceable for the residents' lives. If such shrines and garden trees were removed or cut because they were contaminated, that might cause emotional distress to the residents and lead to degradation of quality of their lives. Therefore, we worked with the residents to coordinate whether decontamination was done or not, as well as choosing the detailed decontamination method based on a comprehensive judgment on the degree of decontamination and the importance for the residents, while listening to their opinions.

## （3） Obtaining consent securely

In implementing this decontamination project, we adhered to obtaining consent from the residents before starting decontamination. We were determined not to perform decontamination forcibly, ignoring the intention of the residents.

This was very important not only in terms of the importance of obtaining consent from the residents from a viewpoint of protecting the right of the residents[76] as mentioned in (2) above, because decontamination could damage or change the properties and agricultural lands of the residents, but also in terms of sharing and agreeing on the decontamination plan with the residents, because there were different objectives and methods of decontamination.

Therefore, we obtained the consent of the residents while giving them in-depth explanations and preparing detailed drawings and materials about decontamination procedures for each decontamination objective.

On the other hand, as mentioned above, there are currently several tens of thousands of displaced people from the evacuation area and more than one hundred thousand including those that fled from outside the evacuation area. To obtain residents' consent to decontamination, it is necessary to identify related persons who have the rights over targets of decontamination and obtain consent regardless of whether they are living there or have evacuated the area. However, there are a great number of decontamination targets: the number of residences to be covered by decontamination solely amounts to from several tens of thousands to several hundred thousand. Especially for the Special Decontamination Areas, where all the residents have evacuated, we need to identify the number of related persons by checking with registry books and other materials, then identify where they have evacuated to and explain the current situation and the method of decontamination to them to obtain consent. Also, in the case that one person owns multiple land plots or buildings, name-base aggregation is required to organize the data. As a result, a great amount of manpower was required to obtain their consent.

Moreover, we could not always obtain the consent after a one-time explanation/discussion. There were many cases in which we finally obtained the consent after we had listened carefully to the

[76] In addition to obtaining consent from residents on the possibility of damages to their properties in the process of implementation of agreed-on decontamination methods, we needed to agree on the conditions of their properties before decontamination so that we could confirm whether damages and loss discovered after decontamination had been caused by decontamination work or not.

requests of the residents, considered such requests and answered their questions again and again.

Especially in the Special Decontamination Areas from where the residents had already evacuated, it was more difficult to obtain the consent, because the residents could not confirm whether there was any inappropriate decontamination work or damage to the buildings for themselves. Therefore, we confirmed their consent on the site and allowed them to be present at the decontamination to observe decontamination work so that the residents could confirm the work with their own eyes. We also provided instruction and education to decontamination business operators and workers, who would obtain the consent from related persons, to respond to such persons sincerely so that they could build a relationship of trust with them.

Although those efforts were made, the degree of consent varied by individual and by area. As a result, the progress of decontamination varied by area, and the areas in which decontamination was underway and those in which it was not were distributed in a patchy fashion.

### 1.3.4. Careful response with consideration for residents' position and feelings

Anxieties and concerns of the local residents are not always related to decontamination. Especially in the Special Decontamination Area, the residents did not necessarily have a positive attitude toward discussing decontamination solely, because the review of the area that served as a base for the decontamination plan was related to the compensation criteria. Therefore, we made careful responses giving thought to situations and feelings of residents of the area, such as bringing staff members who could provide explanations about the review of the area and compensation when we had a briefing session about decontamination.

Also, the residents had a feeling of non-acceptance toward effluent water, as they had an image that contamination was also transferred when water flowed from the premises of their residences to outside, although it was unlikely that effluent water generated as a result of decontamination in the Intensive Contamination Survey Area had a higher level of radioactive concentration. Therefore, we took necessary measures in response to the request of the residents, such as recovery of effluent water.

Furthermore, we also gave consideration to their feelings about visiting their residences: In the seasons when there were many requests for overnight stay, such as the year-end and New Year holidays and the Bon period for visiting their ancestors' graves, we also conducted decontamination prior to these periods.

In addition, the fact that many decontamination workers come to the community from outside means an increase of strangers in the community to the local residents, and they are likely to be concerned about the change of the community's atmosphere, deterioration of public security and generation of traffic jams. To address such concerns, we made many efforts to build a relationship of trust between the local residents and the decontamination workers.