

Research Plan of the Centre for Environmental Creation

[Phase 2]

FY 2019 to FY 2021

(Provisional Translation)

Centre for Environmental Creation



Contents

Introduction

I Radiation Measurement	1
1 Development of analytical and measurement technique	3
2 Evaluation methods of radiation dose, etc. and development of the evaluation models	7
II Decontamination and waste	11
1 Continuous technical support in relation to decontamination, etc.	13
2 Establishing proper disposal and recycling technique of waste, etc.	17
III Environmental Dynamics.....	23
1 Evaluation of transfer behavior	25
2 Transfer models	31
3 Grasping impacts on ecosystems	35
IV Environmental Creation.....	38
1 Creation of a sustainable community.....	40
2 Creation of a resilient society.....	44
3 Creating a life full of nature	47
4 Creation of integrated innovation	50
The Entire Structure of Study and Research Tasks in Phase 2	53
Transition of Study and Research Tasks from Phase 1 to Phase 2	54

Introduction

In the Research Project at the Centre for Environmental Creation, we need to take a series of measures for ten years from FY 2015 to FY 2024, such as grasping the status of contamination and dynamics of radioactive substances, decontaminating affected areas and facilities appropriately, evaluating the results of the decontamination and reducing, storing, disposing of, and recycling the removed soil and contaminated waste to restore and create the environment contaminated with radioactive substances based on the Medium-term and Long-term Action Policies of the Centre for Environmental Creation. And also, we need to promote actions contributing to the recovery of the biota and ecosystems which have changed. Furthermore, in consideration of the transfer of radioactive substances and progress of the decontamination, it is necessary to promote actions aiming at creation of a recycling society, etc. utilizing characteristics of the environment, resources, industries, etc. of/in this area, creation of a society which is resistant to disaster utilizing a lesson from the Great East Japan Earthquake, and establishment of beautiful Fukushima by taking environmental conservation measures in order to create a fascinating and rich environment where the prefecture's residents are and will be able to live safely.

Therefore, we progressed the Research Project in four Divisions ("Radiation Measurement," "Decontamination, and Contaminated Waste Disposal," "Environmental Dynamics," and "Environmental Creation") which contributes to the urgent issues about restoration of environment from the disaster, such as promotion of decontamination, appropriate disposal of removed soil and waste etc. contaminated by radioactive substances, and investigation of environmental dynamics of radioactive substances, and creation of the environment in the prefecture in Phase 1 which is between FY 2015 and FY 2018 with the corporation and collaboration with three organizations (Fukushima prefecture, the Japan Atomic Energy Agency (hereafter, the "JAEA") and the National Institute Environmental Studies (hereafter, the "NIES") and other organizations including IAEA arranged and managed by each Division manager. We gained good results from each Division manager in relation to development of environmental radiation measurement and analytical technique, grasping results of decontamination and establishing an effective decontamination method, safe management of waste and disposal technique including volume reduction, understanding of actual condition of transfer behavior of radioactive substances in the environment and their impacts on wildlife, and development of design technique for models of environmental creation. Additionally, those results reflected to administrative policies of the national government and local governments, and recognized that they contributed to removing various anxieties of the prefecture's residents. On the other hand, there are issues indicated which should be tackled continuously from now on, such as study of further optimization and enhancement of the developed measurement and analytical methods in consideration of implementation in the fields, study regarding transfer assessment of radioactive cesium after waste disposal and safety evaluation, etc. of interim storage of removed soil, etc., clarification of transfer behavior of radioactive substances in the

environment, evaluation of influence of radioactive substances on wildlife and enhancing models based on the preceding result (Environmental Dynamics), and cross-fields study, etc. (Environmental Creation) in relation to design of sustainable regional communities based on scientific evidence for supporting medium-term and long-term recovery program. It was also indicated that the implementation and integration of the results should be promoted, such as strengthening of cooperation with various research institutions, and utilizing developed technique, etc. in field surveys, etc.

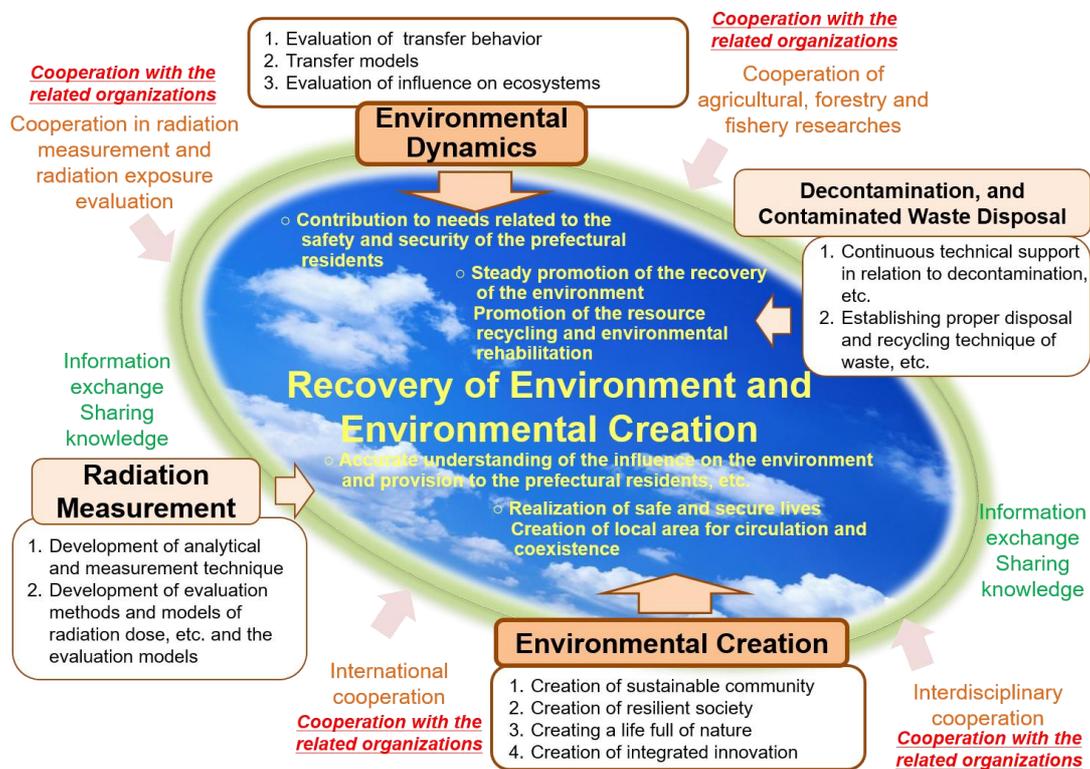
It was also clarified that we should intensify our efforts relatively with long-term and forward-looking perspective from now on in consideration of the changes of social conditions, such as restoring environment and restoration of this prefecture that has made steady progress, evacuation orders that were lifted except for difficult-to-return zones, completion of decontamination in living territory, etc., and aiming at construction of a “Circulating and Ecological Economy” that was set forth in the 5th Basic Environment Plan (Cabinet Decision, April 2018).

Under such background and progress, in Phase 2 which is between FY 2019 and FY 2021, we will keep conducting the Research Project in the four Divisions while further cooperating with each Division and organization and focusing on Divisions of Environmental Dynamics and Environmental Creation to contribute to restoring environment contaminated with radioactive substances and new creation of environment in consideration of results of this project and changes of social conditions. For example, we will conduct study and research regarding developing and enhancing analytical methods, and storing, reducing, recycling the removed soil and contaminated waste, etc. while concentrating on study regarding assessment of long-term environmental dynamics of radioactive substances and their impact on the environment to contribute to restoring environment of the prefectural land. Additionally, we will conduct study and research regarding town development utilizing its environmental resources with a perspective of creating an independent and sustainable town utilizing its distinctive features, building a disaster resilient society, and conservation of prefectural natural environment, such as an aquatic environment of Lake Inawashiro aiming at constructing a circulating and ecological economy area described in the 5th Basic Environment Plan. Other than the original plan, we will also cooperate with the Monitoring Project, etc. for unexpected events, such as forest fires and floods to conduct study and research which contribute to the safety and security of the prefecture’s residents actively and flexibly, such as environmental dynamics of radioactive cesium and its impact on the environment of the vicinities.

In order to promote these study and research effectively, we will strengthen cooperation among each Division, for example, conducting study and research on the same field at the Environmental Dynamics Division and the Environmental Creation Division where we attach importance in Phase 2, and utilizing developed technique, etc. in field surveys, etc. effectively at the Radiation Measurement Division of Phase 1. Additionally, we will conduct the Research Project cooperating with domestic and foreign organizations as well as the other three organizations’ cooperation by utilizing meetings

among Divisions. Furthermore, we will also strengthen close cooperation with projects other than this Research Project and administrative organizations, etc., for holding discussions regularly or the like, so that acquired results are implemented practically. We will also promote to communicate with people around the world, not just that in the prefecture and disseminate information while discussing the best way to disseminate information.

The Research Plan of the Centre for Environmental Creation [Phase 2] (hereafter, the “Research Plan”) means plans which we perform at the four Divisions forming this the Research Project in Phase 2 based on the policies above. The Research Plan is subject to change appropriately based on the progress of the study and research, the changes of social conditions and the needs of the prefecture’s residents upon a liaison and adjustment meeting.



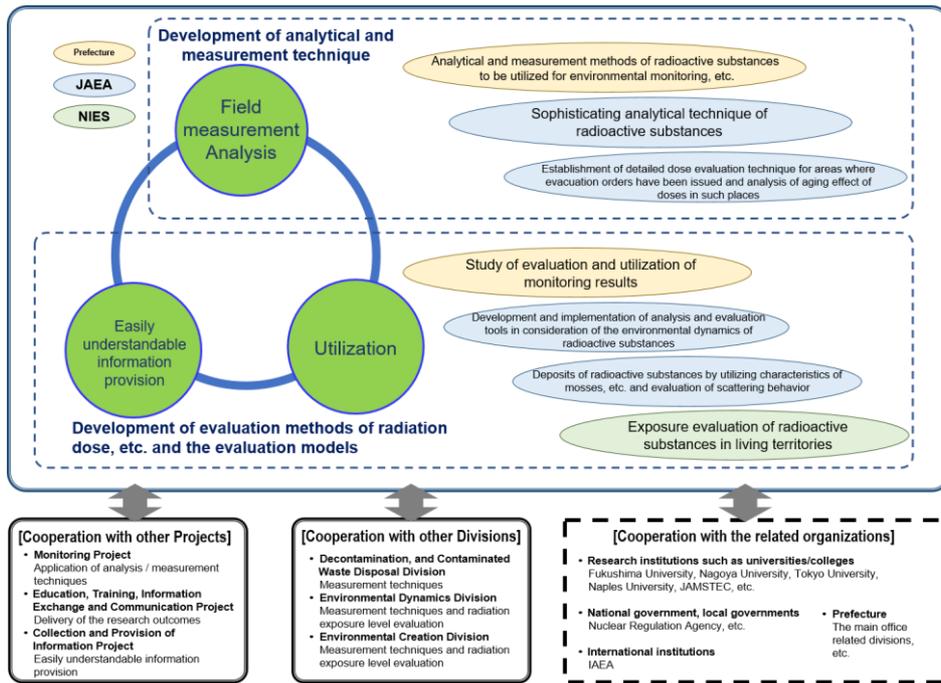
A Conceptual Image of the Research Project

I Radiation Measurement

We need to develop highly-sophisticated analytical and measuring techniques in order to: identify and understand the impacts caused by the Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Station accident (2011) (hereafter, the "accident at the nuclear power station") on its surroundings; identify and understand the impacts from the decommissioning process that will last a long period of time and from the measures taken against contaminated water and from the treatment process of contaminated waste on their surrounding environments; and monitor radiation during an emergency. Also in order to help residents go back to their homes, we need to collect the data concerning the radiation exposure levels at their home areas and concerning the migration of radioactive materials, etc. as well as the information that will enable us to precisely estimate the radiation exposure levels and reduce the levels.

In order to **develop such analytical and measuring techniques**, the Division members will conduct study on the practical use of the techniques developed in Phase 1, optimize those techniques for each analysis specimen, verify the measurement results, and seek to upgrade the techniques, all the while taking account of the progress of the decommissioning process, the state of the measures taken against contaminated water and other social needs. Toward **the development of a method to evaluate radiation exposure levels and model them**, they will also work on the verification of the radiation exposure evaluation model and seek to upgrade it.

All those initiatives will be pursued by other Divisions (mainly the Environmental Dynamics Division) and by other Projects (mainly the Monitoring Project) as well. In case of a natural disaster or other emergency, the Radiation Measurement Division will collaborate with other Divisions and Projects to have a clear grasp of radioactive materials in the surrounding environment.



Structure of Study and Research at the Radiation Measurement Division

1 Development of analytical and measurement technique

(1) Background and purpose

It has been more than eight years since the accident at the nuclear power station, and the concentration of artificial radionuclides has been decreased in living territory due to natural attenuation and decontamination activities, etc. However, there are places where spatial dose rate is still high, such as difficult-to-return zones and places where environmental monitoring has not been conducted yet, such as forests. Additionally, there are issues we need to undertake—grasping impacts of the nuclear power plant accident, treatment of contaminated water, impacts of process of decommissioning of reactors on the surrounding environment, and clarifying the mechanism of the environmental dynamics of radioactive substances in detail. We need to work on the development of analytical and measurement methods required to solve those issues, and simplifying and expediting such technique.

(2) Research Task

- ① Analytical and measurement methods of radioactive substances to be utilized for environmental monitoring, etc. [Fukushima Prefecture]

Regarding analytical method, etc. of low concentration tritium and organically bound tritium (accordingly referred to as “OBT”) worked on in Phase 1, we will perform intercomparison with other organizations, checking and improving accuracy of analysis, and make improvements, such as, simplifying and expediting such technique in consideration of utilizing it in environmental monitoring. At the same time, we will conduct analysis of environmental samples, compare the results with those in other areas, and then summarize them clearly. We will also examine utilization of measurement technique developed in Phase 1, such as walking survey methods, etc., cooperating with administrative organizations and research institutions.

[Details of Tasks]

- Checking and improving accuracy of analysis of low concentration tritium and OBT, and performance of their enhancement
- Test analysis of low concentration tritium and OBT with environmental samples
- Examination on utilization of analytical and measurement technique

- ② Sophisticating analytical technique of radioactive substances [JAEA]

We will make preparations of analytical technique of concentration of radionuclides in samples where life forms, soil, deposits, and element for disturbing analysis coexist, and examine sophistication and application methods of analytical

technique of infinitesimal radioactive substances in environmental samples when necessary, such as analysis of long-term environmental dynamics, etc. in order to make the results of presumptions and solutions of mechanisms of reaction of a micro amount of radioactive cesium and a substance in the solid phase, such as soil, which controls environmental dynamics of radioactive substances lead to forecasts of long-term environmental dynamics and their sophistication.

[Details of Tasks]

- Examination on technique of analyzing radioactive substances with chemical analysis, Time-of-Flight secondary ion mass spectrometry (TOF-SIMS), etc.
- Development of rapid analysis technique on OBT
- Development of rapid analysis technique on radioactive strontium

- ③ Establishment of detailed dose evaluation technique for areas where evacuation orders have been issued and analysis of aging effect of doses in such places [JAEA]
- We have developed analytical technique of the entire regional distribution conditions of radioactive substances in various environments, and have been utilizing it for distribution study of radioactive substances and for projects of the Secretariat of the Nuclear Regulation Authority regarding data aggregation. We will continue to utilize such mapping technique through the framework of projects of Secretariat of the Nuclear Regulation Authority. We will also conduct monitoring of living territory and utilize individual dose evaluation technique. At the same time, we establish dose evaluation technique for non-decontaminated forests, rivers, coastal zones, etc. Furthermore, we will enhance remote measurement technique in the skies, on the ground, and underwater, and promote technology transfer to private business operators, etc. and promote utilization of the technique in other studies, such as study of environmental dynamics, etc.

[Details of Tasks]

- Demonstration and enhancement of measurement technique of radioactive substance in the environment by using unmanned machine
- Utilization of measurement technique of contaminated water in the ocean
- Development of unmanned observation ships for effective monitoring the bottom of the sea
- Wide area mapping with data measured on the ground

(3) Expected results

We will contribute to grasping behavior of radioactive substances in the environment released due to the nuclear power plant accident and impacts of the radioactive substances on the environment, impacts of decommissioning of

reactors and treatment of contaminated water on the environment more accurately. At the same time, we will contribute to evaluations of the wide-area-radiation-dose change caused by transfer of radioactive substances, and radiation dose evaluation which is necessary for restoration and recovery planning of difficult-to-return zones through applying the results done by enhancement and new development of analytical measurement technique to monitoring, and study and research activities.

(4) Schedule

	Phase 1	Phase 2			Phase 3
	~H30 (~2018)	H31 (2019)	H32 (2020)	H33 (2021)	H34~*1 (2022~)
① Analytical and measurement method of radioactive substances to be utilized for environmental monitoring, etc. [Fukushima Prefecture]					
• Checking and improving accuracy of analysis of low concentration tritium and OBT, and performance of their enhancement	→	→	→	→	
• Test analysis of low concentration tritium and OBT with environmental samples	→	→	→	→	→
• Examination on utilization of analytical and measurement technique	→	→	→	→	→
② Sophisticating analytical technique of radioactive substances [JAEA]					
• Examination on technique of analyzing radioactive substances with chemical analysis, Time-of-Flight secondary ion mass spectrometry (TOF-SIMS), etc.	→	→	→		
• Development of rapid analysis technique on OBT	→	→	→	*2	→
• Development of rapid analysis technique on radioactive strontium	→	→	→		
③ Establishment of detailed dose evaluation technique for areas where evacuation orders have been issued and analysis of aging effect of doses in such places [JAEA]					
• Demonstration and enhancement of measurement technique of radioactive substance in the environment by using unmanned machine	→	→	→		
• Utilization of measurement technique of contaminated water in the ocean	→	→	→		
• Development of unmanned observation ships for effective monitoring the bottom of the sea		→			
• Wide area mapping with data measured on the ground	→	→	→	→	→

*1 Examine this based on the progress of study and research in Phase 2 and changes of social conditions (This applies to other “*1” hereinafter.)

*2 Implementation to the site of the environmental dynamics study, etc.

2 Development of evaluation methods of radiation dose, etc. and the evaluation models

(1) Background and purpose

It has been more than eight years since the accident at the nuclear power station, reconstruction in Fukushima has been going on steadily—decontamination activities, a decrease of spatial dose rate of radioactive substances due to natural attenuation, and lifting orders in areas where evacuation orders have been issued along with those. Thus, it is important to provide information about radiation dose of the current and that in the future, spatial dose rate and distribution of radioactive substance, and how to reduce radiation dose to contribute to the safety and security of the prefecture's residents.

(2) Research Task

① Study of evaluation and utilization of monitoring results [Fukushima Prefecture]

We will examine the analytical method integrating each datum of spatial dose rate which has been examined to make work regarding creation of grid square maps (an integrated map, aging effect map) using these data efficient, and reduce time required for such work by examining simplification of the analysis further.

We will also achieve more accurate analysis by increasing measurement areas and data for the creation of grid square maps

[Details of Tasks]

- Examination on the data analytical technique
- Improvement of grid square maps

② Development and implementation of analysis and evaluation tools in consideration of the environmental dynamics of radioactive substances [JAEA]

In Phase 2, we will try to improve the analytical accuracy of models developed in Phase 1. At the same time, we will acquire high accuracy monitoring data utilizing remote radiation measurement technique, and based on the results, we will enhance accuracy of forecasts of change of spatial dose rate, clarify transfer route of radioactive cesium including that in the freshwater ecosystem, and examine application of those results to each measure.

[Details of Tasks]

- Enhancement of the accuracy of forecasts of change of spatial dose rate associated with dynamics of radioactive cesium.
- Clarification of transfer route of radioactive cesium including that in the freshwater ecosystem, and examination on applying those results to each measure

③ Deposits of radioactive substances by utilizing characteristics of mosses, etc. and evaluation of scattering behavior [JAEA]

We will prepare an easy and general evaluation technique of characteristics of scattered substances including radionuclides, amount of scattered substances, and radiation dose. To obtain this, we will analyze chemical forms and behavior of radioactive substances targeting scattered substances accumulated in lichens and bryophytes, and then apply the results to the evaluation of exposure to radiation with scattered substances in the atmosphere. Regarding the results of those chemical forms and behavior, we will also analyze them with the results of detailed distribution analysis of spatial dose rate in mountain areas in dynamics study, etc. to apply them to dynamics models of radionuclides in the environment, etc.

[Details of Tasks]

- Selection of lichens and bryophytes suitable for evaluation of scattered substance
- Measurement of amount of scattered substances and radioactive concentration, and comparison between evaluation of radiation dose and a conventional method
- Evaluation of characteristics of primal accumulated substances in lichens and bryophytes and their accumulation behavior

④ Exposure evaluation of radioactive substances in living territories [NIES]

Continuing from Phase 1, we will perform monitoring of radioactive substances in the living environment (mainly indoor environment and air environment). At the same time, we will conduct improvement internal radiation dose estimation models, preparation of data, cooperation with models of environmental dynamics, more accurate exposure evaluation and forecasts to provide information to the prefecture's residents.

[Details of Tasks]

- Evaluation of internal radiation dose in relation to home harvested food and forecasts the future of such radiation dose
- Environmental monitoring in the areas centering on the areas where evacuation orders were lifted

(3) Expected results

We will provide information leading to the safety and security of the prefecture's residents by analyzing distribution of dynamics of radioactive substances in the environment and living territories to establish and enhance evaluation technique of

distribution of radioactive substances and radiation dose, and building technique of models, and by visualizing fluctuation trend of distribution of spatial radiation dose.

(4) Schedule

	Phase 1	Phase 2			Phase 3
	~H30 (~2018)	H31 (2019)	H32 (2020)	H33 (2021)	H34~*1 (2022~)
① Study of evaluation and utilization of monitoring results [Fukushima Prefecture]					
• Examination on the data analytical technique	→	→	→	→	
• Improvement of grid square maps	→	→	→	→	
② Development and implementation of analysis and evaluation tools in consideration of the environmental dynamics of radioactive substances [JAEA]					
• Enhancement of the accuracy of forecasts of change of air dose distribute in three-dimension associated with dynamics of radioactive cesium	→	→	→	→	→
• Clarification of transfer route of radioactive cesium including that in the freshwater ecosystem, and examination on applying those results to each measure	→	→	→	→	→
③ Deposits of radioactive substances by utilizing characteristics of mosses, etc. and evaluation of scattering behavior [JAEA]					
• Selection of lichens and bryophytes suitable for evaluation of scattered substance	→	→	→		
• Measurement of amount of scattered substances and radioactive concentration, and comparison between evaluation of radiation dose and a conventional method	→	→	→		
• Evaluation of characteristics of primal accumulated substances in lichens and bryophytes and their accumulation behavior	→	→	→	*2	→
④ Exposure evaluation of radioactive substances in living territories [NIES]					
• Evaluation of internal radiation dose in relation to home harvested food and forecasts of such radiation dose	→	→	→	→	
• Environmental monitoring in the areas centering on the areas where evacuation orders were lifted	→	→	→	→	

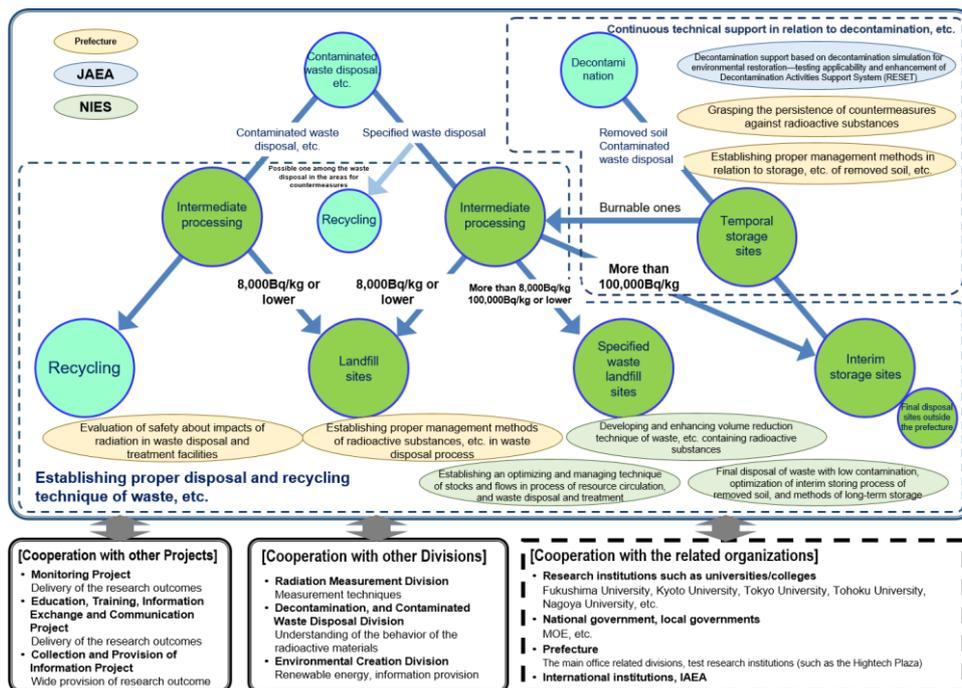
*2 Implementation to the site of the environmental dynamics study, etc.

II Decontamination, and Contaminated Waste Disposal

It is our task to accumulate scientific knowledge about decontamination and share it with residents in order to alleviate their concerns over post-decontamination-work radiation (the district-wide decontamination work is completed except for the Difficult-to-Return Zone). We are also expected to provide technical support for the city and town governments to decontaminate Specified Reconstruction and Revitalization Base. With regard to the handling of removed soil etc., besides the securing of safety at the interim storage facilities and during transport to/from there, we are expected to: restore the temporary storage sites to original state; manage the interim storage facilities over a long time; reduce or reuse such soil for/before the final disposal process outside the Prefecture. With regard to the handling of contaminated waste, we are expected to provide long-term technical solutions for proper control and disposal at the final disposal site.

As **the technical support for the decontamination work**, the Division members will seek to heighten the precision of the decontamination simulation system toward the use by the national and local governments and also toward the use in the research on radiation dynamics. The members will also explore effective anti-radioactive material countermeasures based on the change in the air dose rate at the post-decontamination land and water areas and the methods to properly manage removed soil etc. during transfer and properly restore the temporary storage sites to original state. Moreover, in order to **establish the techniques to properly manage and reuse contaminated waste**, the Division members will conduct research for/on the following: the exact grasp of radioactive nuclide behavior at the final disposal and interim storage facilities and the establishment of proper treatment techniques; the development of a tool that rationally selects, according to radioactivity risk, whether to dispose of or reuse contaminated waste or byproducts generated from radioactive materials at contaminated areas; and the development of a technique to use decontaminated biomass. Briefly speaking, the Division members will study the storing, interim storage, reduction, reuse, and disposal of removed soil and contaminated waste.

In conducting such research, the Division will use the technologies, techniques or knowledge developed or obtained in Phase 1 and will also work with other Projects (mainly the Collection and Provision of Information Project) and align with the national and local administrative agencies. The Division will also join a restoration support initiative led by the Environmental Creation Division.



Structure of Study and Research at the Decontamination, and Contaminated Waste Disposal Division

1 Continuous technical support in relation to decontamination, etc.

(1) Background and purpose

Air dose rate decreases steadily due to natural attenuation of radioactive substances in addition to completion of the regional decontamination work by the municipalities except for difficult-to-return zones. On the other hand, there are residents who still concern of the radiation in the prefecture. Therefore, we will need to examine research and countermeasures to ease the concern of the residents. Since the development of the Designated Reconstruction and Revitalization Sites has started, we will also need to provide information to municipalities where decontamination work is conducted. Since the transportation of the removed soil etc. to the Interim Storage Facilities progresses at present, we need to solve the issues related to the management processes of the removed soil etc., such as safety management when storing and transporting the removed soil, restoration of the temporary storage sites to their original state, and so on. These researches will contribute the safety and security of the prefecture's residents.

(2) Research Task

- ① Grasping the persistence of countermeasures against radioactive substances [Fukushima Prefecture]

Targeting riverbeds, parks, and public facilities, we will grasp accumulation conditions of radioactive substances and change in the air dose rate in medium- to long-term, and also forecast the future of them. If there is any change in situations, we will clarify what causes the change, and examine countermeasures, such as proper management of facilities and revers if necessary.

[Details of Tasks]

- Monitoring of air dose rate in riverbeds and public facilities
- Grasping accumulation conditions of radioactive substances and change in air dose rate and analyzing the cause of the change
- Examination on measures against radioactive substances depending if necessary

- ② Decontamination support based on decontamination simulation for environmental restoration—testing applicability and enhancement of Decontamination Activities Support System (RESET) [JAEA]

We will simulate decontamination activities in difficult-to-return zones, etc. with the decontamination activities support system (RESET), and evaluate the applicability of two-component models of attenuation of spatial dose rate based on

a detailed wide spatial dose rate map (an integrated map). At the same time, we will examine improvement of the attenuation models based on changes of actual spatial dose rate to enhance forecast methods of spatial dose rate. We will utilize the gained results as basic information for environmental dynamics study. At the same time, we will contribute to return of residents and industrial rehabilitation through providing analysis results to the nation and local governments, etc.

[Details of Tasks]

- Decontamination simulation in the Designated Reconstruction and Revitalization Sites with RESET and evaluation of its applicability
- Enhancement of forecast methods of spatial dose rate by improving the attenuation models

③ Establishing proper management methods in relation to storage, etc. of removed soil, etc. [Fukushima Prefecture]

We will estimate and evaluate long-term durability of materials, such as containers for removed soil etc., used in the temporary storage sites. At the same time, we will establish safe storing methods as needed. We will also organize methods and problems for restoring the temporary storage sites to original state, then check the current situation of the sites for evaluation of the restoration methods. Furthermore, we will continue to prepare evaluation system for radiation effect in management flows of removed soil, etc. considering progress of management measures of removed soil, etc., and future changes in social conditions.

[Details of Tasks]

- Estimation and evaluation of long-term durability of materials used in temporary storage sites
- Organizing restoration methods of temporary storage sites to their original states and problems of the methods and checking the current situation
- Improvement of evaluation methods of impacts of radiation in management flows of removed soil, etc.

(3) Expected results

Through providing the results of the researches to the municipalities, such as the forecasting the change in the air dose rate with/after the decontamination work and clarifying the persistence of the countermeasures for the radionuclides, we will provide the basic data for tackling the concern of prefecture's residents about the recontamination after the decontamination work and risks of the radiation dose, and for the countermeasure against the radionuclides in the environments. We will also contribute to utilization of evaluation of long-term durability of materials used in

temporary storage sites and methods of restoration as basic data for proper management of removed soil, etc. by providing the information to municipalities

(4) Schedule

	Phase 1	Phase 2			Phase 3
	~H30 (~2018)	H31 (2019)	H32 (2020)	H33 (2021)	H34~*1 (2022~)
① Grasping the persistence of countermeasures against radioactive substances [Fukushima Prefecture]					
• Monitoring spatial dose rate in riverbeds and public facilities	→	→	→	→	→
• Grasping accumulation conditions of radioactive substances and change situations of spatial dose rate and analyzing the cause of the change	→	→	→	→	→
• Examination on measures against radioactive substances depending on the necessity	→	→	→	→	→
② Decontamination support based on decontamination simulation for environmental restoration—testing applicability and enhancement of Decontamination Activities Support System (RESET) [JAEA]					
• Decontamination simulation in the Designated Reconstruction and Revitalization Sites with RESET and evaluation of its applicability	→	→	→	→*2	→
• Enhancement of forecast methods of spatial dose rate by improving the attenuation models	→	→	→		
③ Establishing proper management methods in relation to storage, etc. of removed soil, etc. [Fukushima Prefecture]					
• Estimation and testing of long-term durability of materials used in temporary yards	→	→	→	→	→
• Organizing restoration methods of restoration of areas which were used as temporary yards and problems of the methods and checking the current situation	→	→	→	→	→
• Improvement of evaluation methods of impacts of radiation in management flows of removed soil, etc.	→	→	→	→	→

*2 Recovery and restoration support in difficult-to-return zones

2 Establishing proper disposal and recycling technique of waste, etc.

(1) Background and purpose

Removed soil and waste arising from decontamination activities and designated waste including general waste and industrial waste arising from contaminated area are depending on their type and place on origin, transported, treated, and stored at interim storage facilities or disposed at disposal facilities for designated waste, and then some of them will be disposed finally outside the prefecture. We will need to study and research to secure proper disposal in each process. Regarding waste other than the above which is technically can be disposed with the same way for municipal waste and industrial waste, many people worry with contamination with radioactive substances that causes delays of disposal tasks. Therefore, we will also need to study and research to carry out their proper disposal. Furthermore, we will also need study and research to utilize biomass, such as bark which is currently disposed as waste.

(2) Research Task

- ① Establishing proper management methods of radioactive substances, etc. in waste disposal process [Fukushima Prefecture]

We will establish a technique to decrease the concentration of radioactive cesium in leachates by utilizing adsorbent, etc. in disposal process of leachates targeting landfill sites for municipal waste and industrial waste. We will also put a technique which prevents radioactive cesium in incinerated ash from eluting after final disposal into practice by utilizing clay mineral targeting landfill sites for municipal waste and industrial waste.

[Details of Tasks]

- Examination on a technique to decrease the concentration of radioactive cesium in leachates in landfill sites
- Examination of developing a technique which makes radioactive cesium in incinerated ash insoluble

- ② Developing and enhancing volume reduction technique of waste, etc. containing radioactive substances [NIES]

Mainly targeting removed soil, etc. and designated waste, we will clarify behavior of radioactive cesium in thermal volume reduction process in temporary intermediate treatment facilities and interim storage sites to develop technologies of thermal volume reduction required in interim storage sites and of high concentration and final waste form methods for final disposal outside the prefecture.

At the same time, we will establish proper operation and maintenance, and demolition methods of intermediate treatment facilities, etc. Additionally, we will develop technologies to generate renewable energy with biomass and clarify behavior of radioactive substances in such process. At the same time, we will test those technologies to evaluate their safety and feasibility.

[Details of Tasks]

- Clarifying behavior of radioactive cesium in thermal volume reduction process, etc.
- Developing technologies of high concentration and final waste form methods in interim storage sites
- Establishing proper operation and maintenance, and demolition methods in intermediate treatment facilities, etc.
- Developing technologies to generate renewable energy and clarify behavior of radioactive substances in such process, and testing these technologies to evaluate their safety

③ Evaluation of safety about impacts of radiation in waste disposal and treatment facilities [Fukushima Prefecture]

Targeting final disposal of municipal waste and industrial waste, we will create simulation models and put them into practice to forecast behavior of radioactive substances. Additionally, we will check if there is any relationship among radioactivity concentration, dose rate on the surface, and contamination density of the surface, and if there is any, we will examine to establish simplified analytical methods to estimate radioactivity concentration based on dose rate on the surface.

We will also evaluate impacts of radioactive substances when biomass fuels are used to generate energy in the vicinity of the site.

[Details of Tasks]

- Forecasting behavior of radioactive substances inside landfill sites at the time of disposal
- Examination of simplified analytical methods of waste brought into waste disposal and treatment facilities
- Grasping behavior of radioactive substances in the process where bark is used

④ Establishing an optimizing and managing technique of stocks and flows in process of resource circulation, and waste disposal and treatment [NIES]

Targeting of waste and by-products in contaminated area with radioactive substances, we will quantify stocks and flows of radioactive substances in the process of disposal and recycling, integrate “stocks and flows” with dynamics

models of radioactive substances in the natural environment, and establish methods to select measures of storage, intermediate treatment, final disposal, and recycling rationally depending on exposure risks. Mainly targeting waste contaminated with radioactive substances in relation to the accident, we will also establish methods to estimate and evaluate concentration of radioactive cesium and other nuclides at the site.

[Details of Tasks]

- Examining evaluation tools which enable to select measures of disposal and recycling of waste and by-products rationally depending on exposure risks
- Examining methods to estimate concentration of radioactive cesium and other nuclides at the site

⑤ Final disposal of waste with low contamination, optimization of interim storing process of removed soil, and methods of long-term storage [NIES]

Mainly targeting designated waste, we will examine estimation of infiltration of cesium and strontium into concrete which is used for interim storing of designated waste with high radioactive concentration substances and final disposal, and examine operation and maintenance of durability. And also, by targeting removed soil, etc. arising from decontamination, we will develop technologies for further optimization of storing methods in interim storing facilities and long-term management, etc. after interim storing. At the same time, we will examine quality evaluation and managing methods to utilize removed soil, etc. effectively. Furthermore, we will also examine concept of final disposal areas for final disposal outside the prefecture.

[Details of Tasks]

- Developing technologies regarding long-term management of final disposal facilities
- Developing technologies for further optimization of storing methods in interim storing facilities and long-term management, etc. after interim storing
- Consider how the final disposal facilities should be and technical study of the facilities for final disposal outside the prefecture

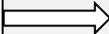
(3) Expected results

We will contribute to reduction and stabilization of designated waste leading to safety storage in interim storage sites and safety transportation and disposal in relation to final disposal facilities outside the prefecture by clarifying the mechanism of thermal volume reduction of designated waste and developing technologies of final waste form methods. And also, we will establish a technique to make

radioactive cesium found in waste insoluble, grasp and estimate the behavior of radioactive cesium inside final disposal facilities, and provide information gained from those activities to municipalities, etc. to contribute to utilization of that information as basic data for long-term proper management of final disposal facilities and acceleration of the understanding of the residents in the vicinities. Furthermore, we will present behavior analysis of radioactive substances at the time of biomass utilization including bark, etc. and present safety evaluation tools for recycling to promote prompt recycle of waste and utilization of biomass resources effectively that properly contribute to promoting resource circulation in the prefecture.

(4) Schedule

	Phase 1	Phase 2			Phase 3
	~H30 (~2018)	H31 (2019)	H32 (2020)	H33 (2021)	H34~※1 (2022~)
① Establishing proper management methods of radioactive substances, etc. in waste disposal process [Fukushima Prefecture]					
• Examination on technique to decrease the concentration of radioactive cesium in leachates in landfill sites	→	→	→	→	→
• Examination of developing technique which makes radioactive cesium in incinerated ash insoluble	→	→	→	→	→
② Developing and enhancing volume reduction technique of waste, etc. containing radioactive substances [NIES]					
• Clarifying behavior of radioactive cesium in thermal volume reduction process, etc.	→	→	→	→	→
• Developing technologies of high concentration and final waste form methods in interim storage sites	→	→	→	→	→
• Establishing proper operation and maintenance, and demolition methods in intermediate treatment facilities, etc.	→	→	→	→	→
• Developing technologies to generate renewable energy and clarify behavior of radioactive substances in such process, and testing these technologies to evaluate their safety	→	→	→	→	→
③ Evaluation of safety about impacts of radiation in waste disposal and treatment facilities [Fukushima Prefecture]					
• Forecasting behavior of radioactive substances inside landfill sites at the time of disposal	→	→	→	→	→
• Examination of simplified analytical methods of waste brought into waste disposal and treatment facilities	→	→	→	→	→
• Grasping behavior of radioactive substances while bark is used	→	→	→	→	→
④ Establishing an optimizing and managing technique of stocks and flows in process of resource circulation, and waste disposal and treatment [NIES]					
• Examining evaluation tools which enable to select measures of disposal and recycling of waste and by-products rationally depending on exposure risks	→	→	→	→	→

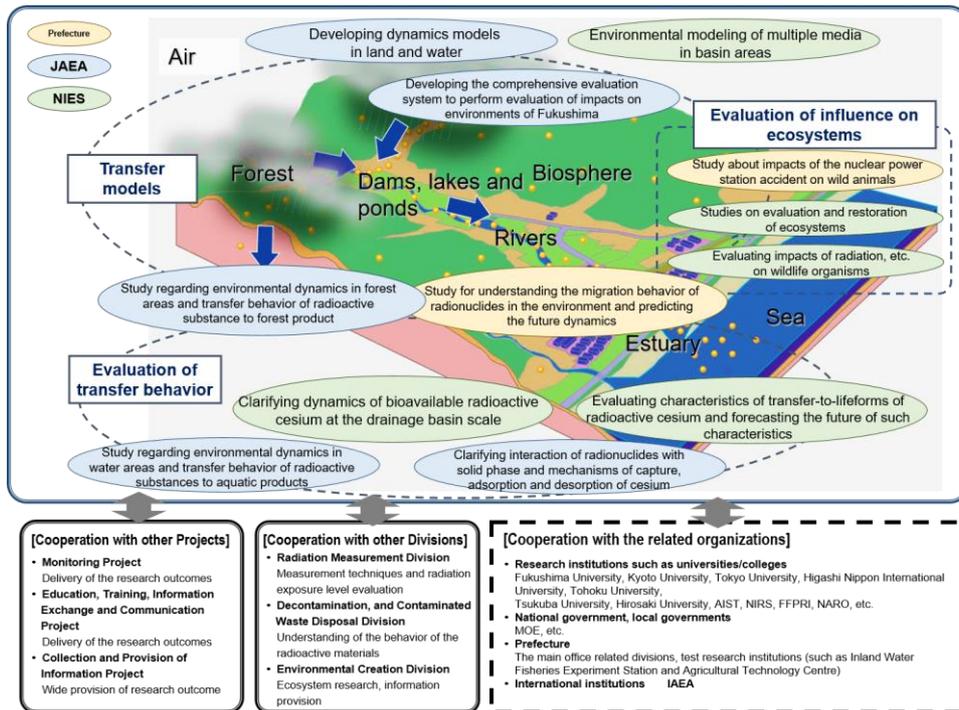
<ul style="list-style-type: none"> Examining methods to estimate concentration of radioactive cesium and other nuclides at the site 					
<p>⑤ Final disposal of waste with low contamination, optimization of interim storing process of removed soil, and methods of long-term storage [NIES]</p>					
<ul style="list-style-type: none"> Developing technologies regarding long-term management of final disposal facilities 					
<ul style="list-style-type: none"> Developing technologies for further optimization of storing methods in interim storing facilities and long-term management, etc. after interim storing 					
<ul style="list-style-type: none"> Consider how the final disposal facilities should be and technical study of the facilities for final disposal outside the prefecture 					

III Environmental Dynamics

The safety and security needs of residents are diversifying as evacuation orders are lifted and residents are returning to their homes and as the measures to counter the decommissioning work and contaminated water are seeing progress. In order to meet such needs of residents, we need to evaluate the direct and indirect impacts of radioactive contamination on people's living environment and on ecosystems and then, based on the results, accumulate and elaborate our knowledge or techniques for controlling the potential risks that exist in people's living and recovering the environment and ecosystem from radioactive contamination.

Toward **the evaluation of the migration behavior of radionuclides**, the Division members will pursue a detailed grasp of the dynamics of radioactive cesium, including the elucidation of the production mechanism of dissolved radioactive cesium at river basins, and will keep their joint activity with the Radiation Measurement Division members in the vicinity of the nuclear power plant to get a clear picture about the area's contamination with radioactive cesium and other radioactive nuclides. Based on the results, the Environmental Dynamics Division will seek to sophisticate its **radioactive cesium migration model**. Furthermore, the Division will continue with the study focused on **radionuclide transfer from environment to wildlife and evaluation of influence** of no resident in the evacuation designated zones on fauna are continue. Using these results, the Division members will develop the population dynamics model. The Division members will also work on the research concerning the management of wildlife and the evaluation and estimation of impacts of land-utilization changes and influences from natural disasters. Based on the results from those research works, the Division members will seek to build an evaluation system database that will enable us to evaluate the direct and indirect impacts of radioactive contamination on people's living environment and ecosystems, construct a medium- to long-term monitoring system. Eventually, the Division members will establish an initial and early-stage environment investigation technique and then an environment-management technique to get us prepared for a natural disaster or other emergency.

The Division members will effectively push forward with all those initiatives by aligning with the Radiation Measurement Division (and its initiative to utilize the developed technologies) and the Environmental Creation Division (and its initiative to support the restoration of disaster-affected areas), by tying up with other Projects (mainly the Collection and Provision of Information Project) and by collaborating with the national and local administrative agencies.



Structure of Study and Research at the Environmental Dynamics Division

1 Evaluation of transfer behavior

(1) Background and purpose

It has been more than eight years since the accident at the nuclear power station, data has been accumulated regarding transfer of radioactive cesium to ecosystems in lands, amount of transfer and deposition (i.e. stocks and flows) of each form of radioactive cesium in many sites such as rivers, dam lakes, etc. Thus, we will continue working on the medium- and long-term monitoring of dissolved radioactive cesium, etc. in forests, rivers, dam lakes, etc. and the prediction for their future dynamics to create the safety and security for the prefecture's residents. At the same time, we will need to understand the current transfer conditions and its mechanism of dissolved radioactive cesium, etc. to forest products and aquatic life. It is also important that we work on to clarify the behavior of radioactive cesium after the natural disaster in river basin areas, and integrate scientific knowledge regarding methods to immediate research and environmental management after the natural disaster to prepare for possible disasters.

(2) Research Task

- ① Study for understanding the migration behavior of radionuclides in the environment and predicting the future dynamics [Fukushima Prefecture]

Continuing from Phase 1, we will monitor the dynamics of radioactive cesium in the sites where we have been working to clarify temporal and spatial changes of radioactive cesium for a long period and the relationship between dynamics of radioactive cesium and land use. And also, we will conduct monitoring surveys, etc. in the case of unexpected events which have impacts on dynamics of radionuclides in the hydrosphere, such as forest fire. We will aim to improve the prediction accuracy by numerical model to compare the simulation with the monitoring results in multiple rivers in Fukushima prefecture. Furthermore, we will examine the capability of our knowledge to the different hydrospheric conditions such as agricultural irrigation ponds and to the investigation of other than radioactive cesium dynamics.

[Details of Tasks]

- Continuous monitoring of radioactive cesium dynamics, etc. in rivers and places where forest fire occurred
- Simulation by a numerical model and improvement of its prediction accuracy for Hirose River and Kuchibuto River.
- Providing technical support and information the project of measures against radioactive substances in agricultural irrigation ponds, etc.

② Study regarding environmental dynamics in forest areas and transfer behavior of radioactive substance to forest product [JAEA]

We will conduct monitoring of distribution of radioactive cesium in each part of the forest and amount of outflowed radioactive cesium in various conditions of forest utilizing remote measurement technique in order to clarify transfer and circulation conditions of radioactive cesium inside and outside forest. Concurrently, we will obtain data in relation to evaluation of external exposure dose of workers in forests and residents in mountain areas in consideration of data above. Furthermore, we will grasp the source of dissolved radioactive cesium, which is accumulated in forest products more easily, and obtain data of change of concentration of dissolved radioactive cesium over the years to clarify mechanism of generation of dissolved radioactive cesium from headwaters of river and leaf litter.

[Details of Tasks]

- Study of distribution of radioactive cesium in each part of the forest and situation of outflowed radioactive cesium
- Study of transfer of radioactive cesium to forest products, such as edible wild plants, etc.
- Obtaining basic data in relation to evaluation of external exposure dose in the forest
- Clarifying mechanism of generation of dissolved radioactive cesium in forest areas

③ Study regarding environmental dynamics in water areas and transfer behavior of radioactive substances to aquatic products [JAEA]

Targeting river systems, their river mouths and coastal areas with relatively large amount of deposited radioactive cesium in drainage basins, we will clarify the fluctuation trend of concentration of dissolved radioactive cesium. At the same time, we will clarify the relationship between such fluctuation trend and leaching conditions of radioactive cesium from leaf litter around headwaters which are upper courses of each river to clarify factors in relation to transfer behavior of radioactive cesium and forecast the transfer behavior utilizing remote measurement technique. And also, we will examine the relationship between aquatic life, such as freshwater fish, etc. and concentration of radioactive cesium to evaluate impacts of radioactive cesium on ecosystems in water areas.

[Details of Tasks]

- Study of transfer behavior of radioactive cesium in rivers, reservoirs, river mouths, and coastal areas

- In-situ tests, etc. in relation to leaching from leaf litter around headwaters at upper courses
- Study of transfer behavior of radioactive cesium to aquatic life, such as freshwater fish
- Evaluation of future fluctuation and transfer of dissolved radioactive cesium

④ Clarifying interaction of radionuclides with solid phase and mechanisms of capture, adsorption and desorption of cesium [JAEA]

We will clarify the phenomena which control transfer nuclides on topsoil and in groundwater (dissolution, condensation, and fixation, etc.) to obtain data which contribute to transfer behavior of radionuclides, such as radioactive cesium for future forecast of concentration of radionuclides arising from the nuclear power plant accident, in the environment including ecosystems. And also, we will evaluate concentration of dissolved nuclides in pore water and groundwater where nuclides transfer to ecosystems more easily. Concurrently, we will clarify partitioning behavior between solid and liquid which controls nuclides transfer in rivers and seawater to evaluate concentration of dissolved state.

[Details of Tasks]

- Clarifying chemical states of radionuclides in the environment

⑤ Clarifying dynamics of bioavailable radioactive cesium at the drainage basin scale [NIES]

We will conduct study and research including regular monitoring of rivers to grasp and forecast dynamics of radioactive cesium in the environment for medium- and long-terms. At the same time, we will evaluate the entire behavior of bioavailable radioactive cesium at upper courses of river systems (forests-dam lakes) and clarify the runoff behavior of dissolved radioactive cesium at city areas around lower course.

[Details of Tasks]

- Evaluating amount of each form of radioactive cesium in bottom sediment in dam lakes, etc.
- Evaluating elution characteristics of radioactive cesium from bottom sediment in dam lakes and examining impact of measures for the elution control
- Evaluating runoff characteristics of radioactive cesium at city areas

⑥ Evaluating characteristics of transfer-to-organisms of radioactive cesium and forecasting the future of such characteristics [NIES]

We will clarify pathways where radioactive cesium transfer from the environment to fish while paying attention to habitats in rivers and lakes, and food webs. At the

same time, we will aim to forecast transfer of radioactive cesium to fish in various environments based on the clarified pathways. And also, we will clarify the relationship between the actual conditions of radioactive cesium transfer to edible wild plants and the existing amount of bioavailable cesium to aim to forecast transfer of radioactive cesium to edible wild plants utilizing ecosystem models while paying attention to behavior of bioavailable radioactive cesium in soil.

[Details of Tasks]

- Clarify pathways where radioactive cesium transfers from the environment to fish
- Forecasting dynamics of concentration of radioactive cesium in the aquatic ecosystem
- Measuring concentration of radioactive cesium in edible wild plants and evaluating existing amount of each form of radioactive cesium in forest soil
- Evaluating characteristics of transfer of radioactive cesium to edible wild plants

(3) Expected results

We will clarify detailed environmental dynamics of dissolved radioactive cesium in forest areas, river systems, and their river mouths and coastal areas, and predict dynamics of radioactive cesium in the environment in medium- and long-term to contribute to dissemination of accurate information to create safety and security of the residents. And also, we will continue monitoring the dynamics of radioactive cesium to detect the impact of unexpected events immediately, such as forest fire, etc., on dynamics of radioactive cesium. We will contribute to accumulation of the scientific knowledge regarding methods of environmental research and management after such unexpected events to prepare for possible disasters. Furthermore, we will evaluate the dose from external exposure for workers in forests and residents in mountainous regions taking into account the distribution of radioactive cesium in forests. Furthermore, we will contribute to the measures by administrator for resuming activities of forests and fishery by elucidating the behavior of transfer of radioactive cesium to forest products, edible plants, fish and aquatic life.

(4) Schedule

	Phase 1	Phase 2			Phase 3
	~H30 (~2018)	H31 (2019)	H32 (2020)	H33 (2021)	H34~*1 (2022~)
① Study for understanding the migration behavior of radionuclides in the environment and forecasting predicting the future dynamics of such behavior [Fukushima Prefecture]					
• Continuing monitoring of radioactive cesium dynamics, etc. in rivers and places where forest fire occurred	→	→	→	→	→
• Simulation by a numerical model and improvement of its prediction accuracy for Hirose River and Kuchibuto River.	→	→	→	→	→
• Providing technical support and information to projects of measures against radioactive substances in agricultural irrigation ponds, etc.	→	→	→	→	→
② Study regarding environmental dynamics in forest areas and transfer behavior of radioactive substance to forest product [JAEA]					
• Study of distribution of radioactive cesium in each part of the forest and situation of outflowed radioactive cesium	→	→	→	→	→
• Study of transfer of radioactive cesium to forest products, such as edible wild plants, etc.	→	→	→	→	→
• Obtaining basic data in relation to evaluation of external exposure dose in forest	→	→	→	→	→
• Clarifying mechanism of generation of dissolved radioactive cesium in forest areas	→	→	→	→	→
③ Study regarding environmental dynamics in water area and transfer behavior of radioactive substances to aquatic products [JAEA]					
• Study of transfer behavior of radioactive cesium in rivers, reservoirs, river mouths, and coastal areas	→	→	→	→	→
• In-situ tests, etc. in relation to leaching from leaf litter around headwaters at upper courses	→	→	→	→	→
• Study of transfer behavior of radioactive cesium to aquatic life, such as freshwater fish	→	→	→	→	→
• Evaluation of future fluctuation and transfer of dissolved radioactive cesium	→	→	→	→	→
④ Clarifying interaction of radionuclides with solid phase and mechanisms of capture, adsorption and desorption of cesium [JAEA]					
• Clarifying chemical states of radionuclides in the environment	→	→	→	→	→
⑤ Clarifying dynamics of bioavailable radioactive cesium at the drainage basin scale [NIES]					

<ul style="list-style-type: none"> • Evaluating the amount of each form of radioactive cesium in bottom sediment in dam lakes, etc. 	→	→			
<ul style="list-style-type: none"> • Evaluating elution characteristics of radioactive cesium from bottom sediment in dam lakes and examining impact of measures for elution control 	→	→	→	→	→
<ul style="list-style-type: none"> • Evaluating runoff characteristics of radioactive cesium at city areas 	→	→	→	→	→
⑥ Evaluating characteristics of transfer-to-lifeforms of radioactive cesium and forecasting such characteristics in the future [NIES]					
<ul style="list-style-type: none"> • Clarify pathways where radioactive cesium transfers from the environment to fish 	→	→	→	→	→
<ul style="list-style-type: none"> • Forecasting dynamics of concentration of radioactive cesium in the aquatic ecosystem 	→	→	→	→	→
<ul style="list-style-type: none"> • Measuring concentration of radioactive cesium in edible wild plants and evaluating existing amount of each form of radioactive cesium in forest soil 	→	→	→	→	→
<ul style="list-style-type: none"> • Evaluating characteristics of transfer of radioactive cesium to edible wild plants 	→	→	→	→	→

2 Transfer models

(1) Background and purpose

While the residents have started to return after the evacuation orders have been lifted, they are getting more interested in enhanced future forecast of migration of radioactive substances in specific media and places rather than about grasping the overall behaviors. On the other hand, there are people who are still concerned about initial exposure, and it is important to clarify actual conditions of those substances. Therefore, we will aim to enhance accuracy of the models which we have developed. At the same time, we will provide knowledge obtained from the study of the environmental dynamics based on scientific evidence, to contribute to lifting evacuation orders, municipalities' planning in relation to return of residents, rational safety measures to reduce radiation exposure, and restoration of agriculture, forestry, and fishery industries.

(2) Research Task

① Developing dynamics models in land and water [JAEA]

In proper consideration to the distribution of crowns of plants and leaf litter in forests, we will develop a model for dynamics of radioactive cesium in catchments considering temperature dependence of leaching dissolved cesium from litter. We will reduce numerical diffusion of the dynamics model in water areas, and improve calculation speed, and expand applications to enhance accuracy of models of dynamics of radioactive cesium in land and water areas.

[Details of Tasks]

- Developing a dynamics model in land area in consideration of environmental dynamics in forest area
- Expanding applications, reducing numerical diffusion, improving calculation speed for the dynamics model in water areas

② Environmental modeling of multiple media in basin areas [NIES]

We will work on medium- and long-term forecast of environmental dynamics of radioactive substance in the atmosphere, land areas, and coastal waters in a river basin to clarify the more probable future which also contribute to the development of medium- and long-term strategic monitoring. Furthermore, we will work on clarifying the actual condition of environmental dynamics and initial radiation exposure right after the nuclear power station accident. We will utilize that results as basic data to evaluate living environmental risks and management of those risks of residents mainly areas where evacuation orders have been lifted and contribute to

activities in relation to environmental management for future nuclear disasters.

[Details of Tasks]

- Enhancing dynamics models paying attention to the physicochemical properties of dissolved radioactive cesium
- Create compartment models targeting dam lake drainage basin
- Clarifying actual conditions of environmental behavior right after the nuclear power station accident

③ Developing the comprehensive evaluation system to perform evaluation of impacts on environments of Fukushima [JAEA]

We will provide knowledge which we obtained from the study of environmental dynamics based on scientific evidence appropriately. We will develop the “comprehensive evaluation system” which is composed of database of spatial dose rate and concentration of radioactive substance (soil, rivers, groundwater, sea water, food, and atmosphere), contents that recreates and forecasts spatial dose rate and the conditions of concentration of radioactive substance, etc. with calculation models, and contents that explains investigation results with Q and A style coherently to announce the results which contributes to municipalities and residents.

[Details of Tasks]

- Developing the comprehensive evaluation system

(3) Expected results

We will develop dynamics models of radioactive cesium in the atmosphere, land and water areas which reflects various environmental factors and enhance accuracy of those models. At the same time, we will clarify dynamics of radioactive cesium sticking to soil and physicochemical dynamics of bioavailable dissolved radioactive cesium, provide information, such as results of study of each measure, to administrative organization, forecast the future of environmental dynamics of radioactive substances in river basin areas, and clarify the actual conditions of environmental behavior right after the nuclear power station accident and initial radiation exposure. Based on the knowledge obtained from these tasks, we will contribute to planning measures to reduce radiation exposure risk in river watersheds, development of methods for environmental risk evaluation and management of residents mainly in areas where evacuation orders have been lifted, and activities in relation to environment management for nuclear disasters in the future. And also, we will provide data and knowledge obtained from the study and research as information based on appropriate scientific evidence, to the people and the administrative organizations, etc. to contribute to administrative measures of

municipalities in relation to lifting evacuation orders and residents' return, study of rational safety measures to reduce radiation exposure, activities of reconstruction of agriculture, forestry, and fishery industries, and removing anxieties and problems of each resident.

(4) Schedule

	Phase 1	Phase 2			Phase 3
	~H30 (~2018)	H31 (2019)	H32 (2020)	H33 (2021)	H34~*1 (2022~)
① Developing dynamics models in land and water [JAEA]					
• Developing a dynamics model in land area in consideration of environmental dynamics in forest area	→	→			→
• Expanding applications, reducing numerical diffusion, improving calculation speed for the dynamics model in water areas	→	→			→
② Environmental modeling of multiple media in basin areas [NIES]					
• Enhancing dynamics models paying attention to the physicochemical properties of dissolved radioactive cesium	→	→			→
• Create compartment models targeting dam lake drainage basin		→			→
• Clarifying actual conditions of environmental behavior right after the nuclear power station accident		→			→
③ Developing the comprehensive evaluation system to perform evaluation of impacts on environments of Fukushima [JAEA]					
• Developing the comprehensive evaluation system		→			→ ^{*2}

*2 Operation and data update

3 Evaluation of influence on ecosystems

(1) Background and purpose

It is important for us to know the impacts of radiation in the environment on wild organisms around us in order to have the residents in the prefecture feel safe. However, there is no clear criteria for evaluation of impacts of radiation on wildlife in Japan. Therefore, we will need to evaluate impact of the current radiation level in the evacuation designated zones on wildlife. Radionuclides have been detected in wildlife due to transfer from the environment. This is not only having impacts on wildlife, but also it has become a problem from the perspective of resource utilization. Therefore, we will need to clarify transfer mechanism of radionuclides from the environment to wildlife and the dynamics of radionuclides of wildlife. On the other hand, changes are expected on biota because there are no residents the evacuation designated zones for long time, because activities on land management by residents have been stopped. Hence, we will need to conduct monitoring on biota in the evacuation designated zones and the vicinities of these zones, etc. to provide these information that contribute to the management of the wildlife and birds. And also, we will need to develop management methods for wide areas based on prediction models of distribution and dynamics of wildlife.

(2) Research Task

- ① Study about impacts of the nuclear power station accident on wild animals [Fukushima Prefecture]

We will study on the dynamics of radionuclides, food habits, and behavior of wild boars, Asian black bears, etc. And also, we will focus on monitoring animal species in which relatively low concentration of radioactive cesium is detected in their muscles to study to contribute to their resource utilization. Furthermore, we will research distribution and behavior of Asian black bears, which may expand their distribution and increase their population, in the evacuation designated zones and the vicinities of these zones.

[Details of Tasks]

- Study of dynamics of radionuclides in wild animals
- Developing monitoring technique on wild animals and studying their behavior and utilization
- Studying distribution and ecology of game animals and birds in the evacuation designated zones and the vicinities of these areas

② Evaluating impacts of radiation, etc. on wild organisms [NIES]

We will develop model organisms or index that can be monitored DNA damage and improve evaluation technique of accumulation of DNA mutation. Based on these data, we will create a hazard map which shows accumulation of DNA mutation at difficult-to-return zones. In addition, we will study on wild large Japanese field mice captured in forests and study on biota comprehensively in the coastal area, in which sustained damage by tsunami and contamination due to the nuclear power station accident, to unravel impacts of radiation on procreation and survival of wildlife and its cause.

[Details of Tasks]

- Developing new model organisms and index of DNA damage and evaluation of accumulation of DNA mutation using these index
- Studying on impacts on wild large Japanese field mice and conducting study of biota in tidal zones

③ Studies on evaluation and restoration of ecosystems [NIES]

We will continue to study on fauna, entomofauna, and avifauna inside and outside of areas where evacuation orders have been issued. At the same time, we will develop simple monitoring methods to secure its continuity. And also, we will clarify change of land cover associated with human activities and combine this data and wild organisms monitoring data to create distribution change models and present those results rapidly and continuously as soon as possible.

[Details of Tasks]

- Conducting biota monitoring inside and outside of areas where evacuation orders have been issued and improving monitoring methods
- Constructing and refining of distribution change models on wild organisms

(3) Expected results

We will clarify transfer mechanism of radionuclides from the environment to wildlife and clarify dynamics of radionuclides in wildlife in order to contribute to improvement of methods for radionuclides concentration monitoring on game animals and birds which is conducted in the prefecture. And also, we will evaluate the impacts of radiation on wildlife and develop an index for monitoring those impacts to contribute to radiation risk management and ecosystem management in the future. Furthermore, we will evaluate the current status of fauna in the evacuation designated zones to contribute to wildlife management and ecosystem management in not only the evacuation designated zones, but also in areas where there are similar disturbances (such as a steep decrease in population).

(4) Schedule

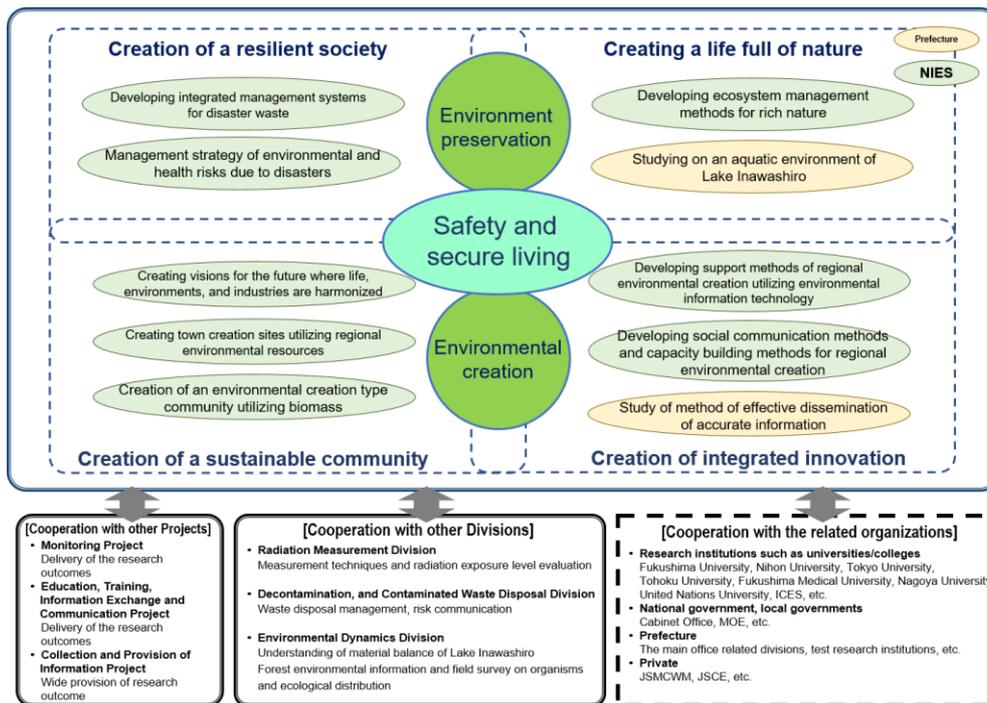
	Phase 1	Phase 2			Phase 3
	~H30 (~2018)	H31 (2019)	H32 (2020)	H33 (2021)	H34~※1 (2022~)
① Study about impacts of the nuclear power station accident on wild animals [Fukushima Prefecture]					
• Study of dynamics of radionuclides in wild animals	⇒	→	→	→	→
• Developing monitoring technique on wild animals and studying their behavior and utilization		→	→	→	→
• Studying distribution and ecology of game animals and birds in the evacuation designated zones and the vicinities of these areas		→	→	→	→
② Evaluating impacts of radiation, etc. on wild organisms [NIES]					
• Developing new model organisms and index of DNA damage and evaluation of accumulation of DNA mutation using these index	⇒	→	→	→	→
• Studying on the impacts on wild large Japanese field mice and conducting study of biota in tidal zones	⇒	→	→	→	→
③ Studies on evaluation and restoration of ecosystems [NIES]					
• Conducting biota monitoring inside and outside of areas where evacuation orders have been issued and improving monitoring methods	⇒	→	→	→	→
• Constructing and refining of distribution change models on wild organisms	⇒	→	→	→	→

IV Environmental Creation

As the works for the restoration and rebirth of Fukushima are steadily underway, the Prefecture is no longer an exception when it comes to the creation of a Regional Circular and Ecological Sphere (which is set forth in the 5th Basic Environment Plan). Amid such background, we are expected to continue with the research for the restoration of the beautiful and natural-rich environment and the creation of an environment-friendly and sustainable society that is also safe to live in and resilient against disasters, and are then expected to apply those research findings, through an integration approach, to the initiatives for realizing, beyond restoration, a future-oriented, sustainable environment for Fukushima.

The Division's initiatives to **turn the Prefecture sustainable** include: the development of a restoration scenario that also works for the creation of a new environment; research on the way to support energy business; and the model improvement concerning the use of forests at disaster-affected areas. The initiatives to **make Fukushima more resilient against disasters** include: the development of techniques and public management methods to control environmental risk factors, such as disaster wastes and chemical substances, and the verification of those techniques and methods. Toward **the realization of a nature-rich environment**, the Environmental Creation members will conduct a quantitative evaluation of the flow, stock, etc. of the substances contained in Lake Inawashiro and also seek to establish a method to control forests and ecosystems. Also with in mind the concepts of the "development of data coordination infrastructure" and the "logical path and chronological order for the processes from basic research to social implementation and global diffusion" of the Integrated Innovation Strategy approved by the Cabinet in June 2018 and in order to **generate an innovation** for the Environmental Creation Division, the Division members will work on the following: the development of a Community Capacity Building method (for those who involved in a local society activity to acquire or improve their abilities to attain certain goals) toward the regional revitalization; the update of the regional environmental information system and its verification operation toward the projection of the region's environment in the future; and a study to find an accurate and easy-to-understand form of information provision.

In order to effectively push forward with all those initiatives, the Environmental Creation Division will work in alignment with other Divisions (mainly the Environmental Dynamics Division) and other Projects (mainly the Collection and Provision of Information Project) and will collaborate with the national and local administrative agencies.



Structure of Study and Research at the Environmental Creation Division

1 Creation of a sustainable community

(1) Background and purpose

As environmental restoration work from environmental contamination with radioactive substances progresses, evacuation orders have been lifted in some areas, some residents have returned, and reconstruction of affected areas are under way.

Reconstruction begins to enter a new stage while in economic side, creation of new industries based on the Fukushima innovation coast plan has been planned and under way, and decontamination of the Designated Reconstruction and Revitalization Sites has begun in difficult-to-return zones. On the other hand, there are many issues that we have to work on along with the reconstruction, such as adjusting to global warming, utilizing renewable energy in the areas, and town creation in consideration of the aging society and declining birthrate. We will need to analyze various aspects quantitatively, such as creating sustainable visions of whole region for the future, activities of town creation at each site, utilization support for forest which is main regional resource in Fukushima Prefecture, and study to support regional activities based on scientific evidence.

(2) Research Task

- ① Creating visions for the future where life, environments, and industries are harmonized [NIES]

We will solve various environmental and social issues and create building methods of quantitative visions for the future to implement medium- and long-term environmental creation type reconstruction. For example, we will enhance regional integration evaluation models spatially which were developed in Phase 1 and expanding them to related fields, such as land use, agriculture, ecosystems, etc. to make it capable to evaluate the future models with various indices. We will check applicability of the developed methods in municipalities.

[Details of Tasks]

- Expanding regional information database, especially spatially more accurate information, reconstruction work after the Great East Japan Earthquake, organizing information regarding reconstruction sites, etc.
- Enhancing regional integration evaluation models in terms with time and space and expanding them to related fields
- Checking applicability of the developed methods in municipalities and creating two-way scenarios building methods where related people cooperate with each other and generalizing those methods

② Creating town creation sites utilizing regional environmental resources [NIES]

We will develop and expand planning support frame work of distributed energy system which have been developed targeting Shinchi town and Mishima town so that study regarding ripple effect on regional economy and employment of site programs, and utilization of biomass waste from affected areas can be conducted. And also, we will develop technology inventory databases based on leading environmental energy project researches, and collect them with design guideline style, etc. as creation methods of general environmental sites so that they can be applicable in other areas including non-affected areas.

[Details of Tasks]

- Improving planning support frame work of distributed energy system
- Basic research and examining measures for energy transformation of biomass waste from affected areas
- Collecting creation methods of environmental sites and developing design guidelines, etc.

③ Creation of an environmental creation type community utilizing biomass [NIES]

We will improve the integrated biomass utilizing model (BaIM) develop in Phase 1 optimizing model parameter to enhance the accuracy. And also, we will analyze scenarios with BaIM when a type of forest change and conservation of ecosystem, etc. are performed to forecast long-term biomass demand and its impact evaluation assuming specific woody biomass utilizing sites cooperating with the ecosystem study and renewable energy system design study.

[Details of Tasks]

- Improving the integrated biomass utilizing model
- Analyzing scenarios when a type of forest change and conservation of ecosystem, etc. are performed
- Forecasting long-term biomass demand and its impact evaluation assuming specific woody biomass utilizing sites

(3) Expected results

Once creation methods of visions for the future of reconstruction are developed, we can show the image of aiming future community quantitatively and can evaluate activities necessary to achieve the goal and contribution to the goal. Particularly, we will analyze long-term results of various on-going activities from various aspects, such as environments, economy, societies, etc. to contribute to formulation and evaluation of plans, etc. And also, we will develop models and database regarding

distributed energy system to support creation of regional sites utilizing environmental resources. At the same time, we will collect those results as design guidelines as basic data for realizing regional revitalization to contribute to administrative measures and private regional planning. Furthermore, we will provide multiple forest management scenarios through long-term simulation of forest utilization to contribute to promotion of utilizing ligneous resources for coexisting with regional industries and lives. And also, we will present specific case studies of good practices of biomass utilization to contribute to wider areas in the country with generalizing methods.

(4) Schedule

	Phase 1	Phase 2			Phase 3
	~H30 (~2018)	H31 (2019)	H32 (2020)	H33 (2021)	H34~ ^{※1} (2022~)
① Creating visions for the future where life, environments, and industries are harmonized [NIES]					
<ul style="list-style-type: none"> Expanding regional information database, especially spatially more accurate information, reconstruction work after the Great East Japan Earthquake, organizing information regarding reconstruction sites, etc. 					
<ul style="list-style-type: none"> Enhancing regional integration evaluation models in terms with time and space and expanding them to related fields 					
<ul style="list-style-type: none"> Checking applicability of the developed methods in municipalities and creating two-way scenarios building methods where related people cooperate with each other and generalizing those methods 					
② Creating town creation sites utilizing regional environmental resources [NIES]					
<ul style="list-style-type: none"> Improving planning support frame work of distributed energy system 					
<ul style="list-style-type: none"> Basic research and examining measures for energy transformation of biomass waste from affected areas 					
<ul style="list-style-type: none"> Collecting creation methods of environmental sites and developing design guidelines, etc. 					
③ Creation of an environmental creation type community utilizing biomass [NIES]					
<ul style="list-style-type: none"> Improving the integrated biomass utilizing model 					
<ul style="list-style-type: none"> Analyzing scenarios when a type of forest change and conservation of ecosystem, etc. are performed 					
<ul style="list-style-type: none"> Forecasting long-term biomass demand and its impact evaluation assuming specific woody biomass utilizing sites 					

2 Creation of a resilient society

(1) Background and purpose

We have been exposed to various natural disasters throughout the country even after the Great East Japan Earthquake. Although measures against disaster waste for recovery and restoration of the affected areas are in place systemization of knowledge for improving ability to respond to disasters and development of technique and management methods for practice are incomplete. Various studies on management and evaluation of environment and health risks in relation to harmful substances and components in normal situations have been widely conducted, however, activities for risk management in case of disasters are lagging far behind. Therefore, we will need to develop and evaluate proper disposal methods of disaster waste, technique and system for environmental risk management of chemical substances, public management methods and develop human resources for those to contribute to creation of a resilient society against disasters

(2) Research Task

① Developing integrated management systems for disaster waste [NIES]

Regarding systemization of technique and management methods in relation to disaster waste management, we will verify and evaluate their applicability through trials towards actual implementation, cooperating with the national government, municipalities, and other related organizations for actual implementation. And also, we will aim to develop and enhance information infrastructure to support such implementation. At the same time, we will develop human resource training program and promote its dissemination.

[Details of Tasks]

- Research and analysis of various disaster cases in the past
- Developing management methods of disaster waste disposal for small size municipalities
- Improvement and operation of the disaster waste information platform
- Developing and implementing education and training program for human resource development

② Management strategy of environmental and health risks due to disasters [NIES]

We will study on risk management methods at disaster situations, environmental research methods at disaster situations, and exposure and impacts on the environment in land and sea areas at disaster situations to establish management

strategy for environmental and health risks associated with disasters.

[Details of Tasks]

- Developing scenarios of discharge and leakage associated with disasters and accidents
- Developing methods for quick analysis, and various components analysis
- Developing environmental research methods for land and sea areas and study of risk evaluation methods
- Study of management strategy for environmental and health risks expected at disasters and accidents

(3) Expected results

We can provide management methods and practical tools for disaster waste management to small size municipalities where studies were not conducted enough in Phase 1 by generalizing and organizing problems in relation to disaster waste management according to characteristics of disasters in the past. The features and contents of information platform which is a foundation of proper management will be enhanced and are expected to be utilized at normal, and disaster and emergency situations. Furthermore, education and training program for various human resource development according to targets and purposes will be developed and it is expected to be used widely. And also, we will carry out study of environmental research; analysis and evaluation methods required at disaster situations, environmental research methods and example, and direction of risk management based on these studies to contribute to establishment of risk management strategy for environmental and health risks associated with disasters.

(4) Schedule

	Phase 1	Phase 2			Phase 3
	~H30 (~2018)	H31 (2019)	H32 (2020)	H33 (2021)	H34~※1 (2022~)
① Developing integrated management systems for disaster waste [NIES]					
• Research and analysis of various disaster cases in the past	⇒	→			
• Developing management methods of disaster waste disposal for small size municipalities	⇒	→			
• Improvement and operation of the disaster waste information platform	⇒	→	→	→	→
• Developing and implementing education and training program for human resource development	⇒	→	→	→	→
② Management strategy of environmental and health risks due to disasters [NIES]					
• Developing methods for quick analysis, and various components analysis	⇒	→			
• Developing methods for quick analysis, and various components analysis	⇒	→	→	→	→
• Developing environmental research methods for land and sea areas and study of risk evaluation methods	⇒	→	→	→	→
• Study of management strategy for environmental and health risks expected at disasters and accidents			→	→	

3 Creating a life full of nature

(1) Background and purpose

While reconstruction and revitalization of Fukushima make steady progress, we will need to conduct more study and research regarding natural environmental conservation and ecosystem management, etc. for realizing an environment full of nature where the prefecture's residents are and will be able to live safely. For example, we will need to clarify the cause of the deterioration of water quality and conduct study and research of future forecast of the water quality in Lake Inawashiro where deterioration of water quality has been getting obvious along with neutralization of pH in the water of the lake (COD level increases and number of colitis germ legions exceeds the environment reference.) And also, we will need to evaluate impacts of forest management and forest conversion in consideration of socioeconomic factors on biodiversity and ecosystem services in the forest ecosystem which occupies 70% of the Fukushima Prefecture, and where aging issues of trees in the artificial forest and lack of management are becoming issues.

(2) Research Task

① Studying on an aquatic environment of Lake Inawashiro [Fukushima Prefecture]

We will enhance grasping the current and actual conditions continuing from Phase 1 to clarify mechanism of deterioration of water quality from aspects of quantitative evaluation on material stocks and flows, etc. of water quality of Lake Inawashiro (material balance), and develop water quality simulation models based on that clarified results. Furthermore, we will examine effective measures, etc. for improving the current water quality and maintain that for the future.

[Details of Tasks]

- Grasping the current and actual conditions of the water quality in Lake Inawashiro and rivers which flow into the lake
- Clarifying the cause of the deterioration of the water quality
- Developing water quality simulation models
- Examining improving the water quality

② Developing ecosystem management methods for rich nature [NIES]

We will research more detailed forest environment information, life and ecosystem distribution than that obtained in Phase 1, targeting Aizu region, etc. We will propose zoning of type of forest and tree species in consideration of socioeconomic factors, examine desirable forest management methods from the viewpoint of ecosystem management through impact of forest management accordingly on biodiversity and

ecosystem services, and also generalize the developed methods.

[Details of Tasks]

- Checking and estimating forest environment information, life and ecosystem distribution
- Developing models of impacts on ecosystem and ecosystem services, etc. and estimating zoning of type of forest and tree species in consideration of socioeconomic factors utilizing the developed models
- Generalizing and applying the methods to other areas

(3) Expected results

We will clarify the cause of the deterioration of the water quality based on quantitative evaluation on water quality of Lake Inawashiro. At the same time, we will forecast the aquatic environment of the future with water quality simulation models and propose measures of improving water quality to the administrative organizations to contribute to conservation of natural environment. Furthermore, we will obtain more accurate forest environment information, and provide results estimated widely and forest zoning where conservation of ecosystem and socioeconomic wood use can coexist through long-term forest simulation to contribute to desirable forest management methods. We will also contribute to wider areas in the country with generalizing methods.

(4) Schedule

	Phase 1	Phase 2			Phase 3
	~H30 (~2018)	H31 (2019)	H32 (2020)	H33 (2021)	H34~ [※] 1 (2022~)
① Studying on water environment of Lake Inawashiro [Fukushima Prefecture]					
• Grasping the current and actual conditions of the water quality in Lake Inawashiro and rivers which flow into the lake	⇒	→			→
• Clarifying the cause of the deterioration of water quality		→			→
• Developing water quality simulation models			→		→
• Examining improving the water quality				→	→
② Developing ecosystem management methods for rich nature [NIES]					
• Checking and estimating forest environment information, life and ecosystem distribution	⇒	→			
• Developing models of impacts on ecosystem and ecosystem services, etc. and estimating zoning of type of forest and tree species in consideration of socioeconomic factors utilizing the developed models	⇒	→			
• Generalizing and applying the methods to other areas				→	→

4 Creation of integrated innovation

(1) Background and purpose

While the entire regional decontamination process has been completed except for difficult-to-return zones, and infrastructure of living environment has been developed, the reconstruction and restoration of Fukushima has made steady progress.

Hence, we will need to support them with issues in relation to environmental creation, such as restoration of regional communities after the residents' return, response to social needs in relation to regional environment with diversification, easing worries of the residents about radiation risks, tenacious rumors from study and research aspects, such as revitalizing social communication, identifying social needs which stakeholders, etc. have and creation of a new mechanism to share such information, developing methods of social dialogue and human resource training, and methods of dissemination of accurate information.

(2) Research Task

① Developing support methods of regional environmental creation utilizing environmental information technology [NIES]

We will develop information sharing system which performs evaluation on regional living environment and support of environment-oriented actions effectively, and develop regional community life support methods in consideration of various regional needs for life and environment.

[Details of Tasks]

- Evaluating regional environment through analyzing social monitoring data
- Social monitoring data and modeling of living activities with geographic information analysis
- Examination of area rehabilitation and revitalization measures from the viewpoint of the residents through information analysis of living activities

② Developing social communication methods and capacity building methods for regional environmental creation [NIES]

We will conduct interview and questionnaire surveys on municipalities' officials to identify study needs in relation to environmental creation. At the same time, we will clarify actual situation of participation of the residents, their evaluation and awareness toward municipalities' environmental policies and environmental conservation activities in regional communities through questionnaire on the residents. Furthermore, we will develop methods of social dialogue and human

resource training in relation to environmental creation through conducting citizen participation type scientific communication activities, such as workshops.

[Details of Tasks]

- Interview and questionnaire surveys about needs of administration and residents to municipalities in relation to environmental creation
- Citizen participation type scientific communication activities (workshops, etc.)
- Generalizing developing methods of social dialogue and human resource training in relation to environmental creation and developing tools for those methods

③ Study of method of effective dissemination of accurate information [Fukushima Prefecture]

We will statistically analyze the questionnaire which the prefecture has conducted to clarify various anxieties of the prefecture's residents and the cause and information which each attribute (target) requires. And also, we will hold a workshop in relation to aquatic environment, conduct questionnaire survey, and analyze the data to verify the effects of environmental conservation activities with regional dialogue on revitalization.

[Details of Tasks]

- Statistical analysis of existing questionnaire results
- Holding a workshop in relation to aquatic environment, conducting questionnaire survey, and analyzing the data

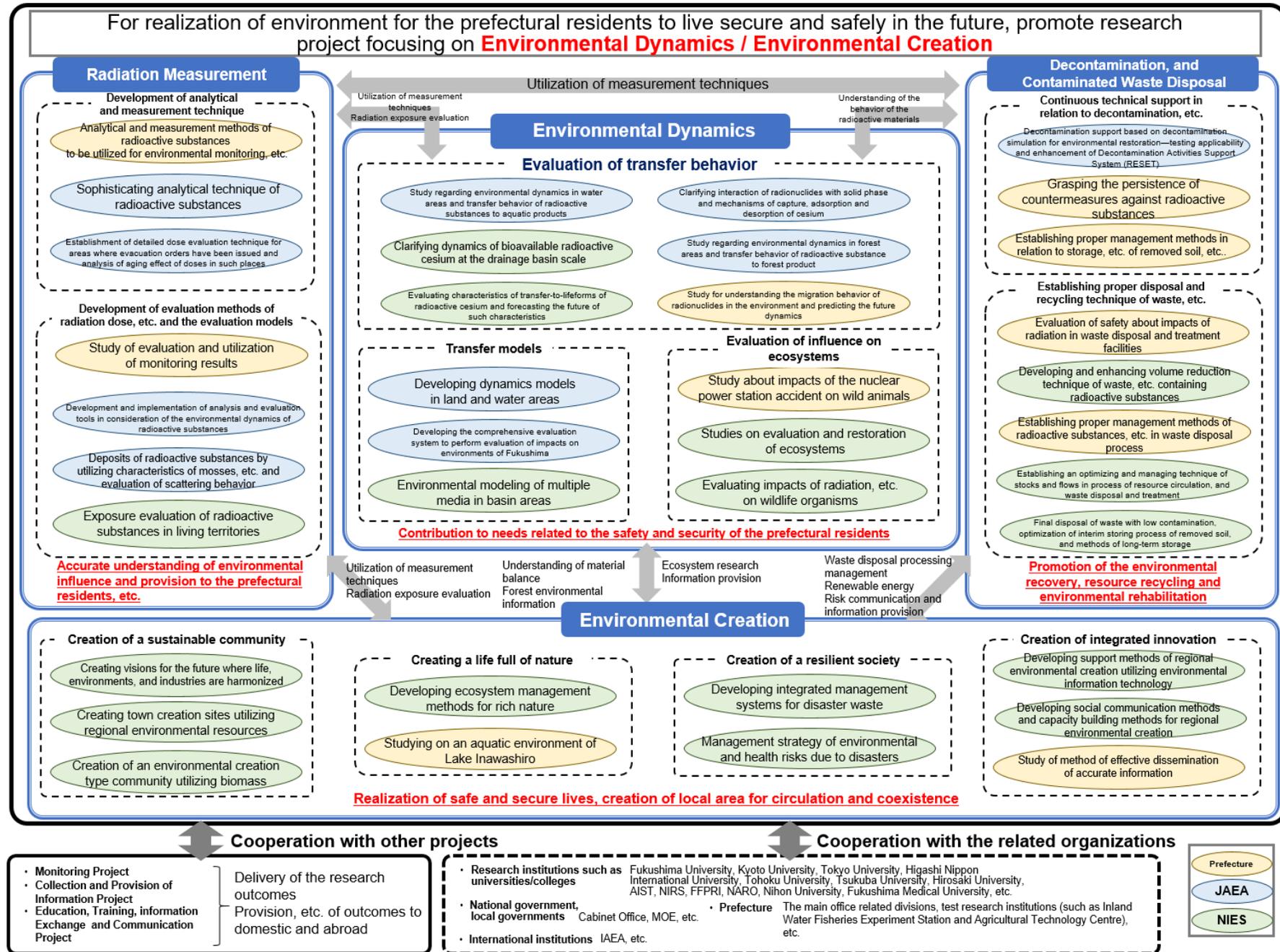
(3) Expected results

We will develop regional community life support methods utilizing regional information system, environmental monitoring system, etc. and expand them to various regions in the prefecture to contribute to realization of comfortable and sustainable living environment. And also, we will clarify the needs of stakeholders in relation to environmental creation. At the same time, we will develop methods of social dialogue and human resource training in relation to environmental creation through citizen participation type social communication activities and provide information of those to contribute to effective policy making. And also, we will clarify anxieties about radiation risks which anyone who receives the information has, such as the residents in the prefecture, including the causes and approaches of dissemination of information, and provide the clarified information to the administrative organizations to contribute to utilization of effective measures.

(4) Schedule

	Phase 1	Phase 2			Phase 3
	~H30 (~2018)	H31 (2019)	H32 (2020)	H33 (2021)	H34~※1 (2022~)
① Developing support methods of regional environmental creation utilizing environmental information technology [NIES]					
• Evaluating regional environment through analyzing social monitoring data	→	→			
• Social monitoring data and modeling of living activities with geographic information analysis			→	→	
• Examination of area rehabilitation and revitalization measures from the viewpoint of the residents through information analysis of living activities				→	→
② Developing social communication methods and capacity building methods for regional environmental creation [NIES]					
• Interview and questionnaire surveys about needs of administration and residents to municipalities in relation to environmental creation		→	→	→	
• Citizen participation type scientific communication activities (workshops, etc.)			→	→	→
• Generalizing developing methods of social dialogue and human resource training in relation to environmental creation and developing tools for those methods				→	→
③ Study of method of effective dissemination of accurate information [Fukushima Prefecture]					
• Statistical analysis of existing questionnaire results	→	→	→	→	→
• Holding a workshop in relation to aquatic environment, conducting questionnaire survey, and analyzing the data	→	→	→	→	→

The Entire Structure of Study and Research Tasks in Phase 2



Transition of Study and Research Tasks from Phase 1 to Phase 2

[Radiation Measurement Division]

Phase 1				Phase 2		
FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021
A. Development of analysis methods				A. Development of analytical and measurement technique		
① Development of methods to analyze radioactive nuclide easily and quickly				① Analytical and measurement methods of radioactive substances to be utilized for environmental monitoring, etc.		
② Enhancement of radiation analysis techniques				② Enhancement of radioactive materials analysis techniques		
B. Development of measurement technologies						
① Research on techniques to measure the air radiation dose and radioactive materials				(Integrated in A ① Analytical and measurement methods of radioactive substances to be utilized for environmental monitoring, etc.)		
② Enhancement of radiation / dose measurement techniques using unmanned helicopter				③ Establishment of detailed dose evaluation technique for areas where evacuation orders have been issued and analysis of aging effect of doses in such places		
③ Research and development on wide area radiation measurement flying objects						
④ Development of techniques to monitor and measure radiation behavior in water						
⑤ Development of techniques to measure radioactive materials in water						
⑥ Applied research of techniques to measure radiation distribution in forest areas using simple visualization techniques <small>(The research is completed)</small>						
C. Methods for presenting measurement results				B. Development of evaluation methods of radiation dose, etc. and the evaluation models		
① Study of evaluation and utilization of the monitoring results				① Study of evaluation and utilization of monitoring results		
D. Development of evaluation methods and models of the radiation exposure levels						
① Research on migration behavior of radioactive cesium in living space / urban environment and Maintenance of radiation rate change prospect models				(Moved to the Environmental Dynamics Division)		
② Study of evaluation and control of individual exposure radiation level						
③ Development and maintenance of exposure analysis and evaluation tools which take into account environmental dynamics of radioactive materials				② Development and implementation of analysis and evaluation tools in consideration of the environmental dynamics of radioactive substances		
(Moved from the Environmental Dynamics Division)				③ Deposits of radioactive substances by utilizing characteristics of mosses, etc. and evaluation of scattering behavior		
④ Research and study of evaluation of exposure to radioactive materials and hazardous chemicals				④ Evaluation of exposure to radioactive materials in living space		

54

[Decontamination, and Contaminated Waste Disposal Division]

55

Phase 1				Phase 2		
FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021
A. Development of technologies for decontamination and migration inhibition				A. Continuous technical support in relation to decontamination, etc.		
① Study on radioactive material removal in rivers, lakes, etc.				① Grasping the persistence of countermeasures against radioactive substances		
② Development of technology for inhibition of radioactive cesium migration (The research is completed)						
B. Evaluation of decontamination effects and environmental impacts						
① Study of evaluation of decontamination effects				(Integrated in A ① Grasping the persistence of countermeasures against radioactive substances)		
② Decontamination technology support based on decontamination simulation for support of environmental recovery technology - Applicability evaluation of the "Decontamination Activity Support System (RESET)"				② Decontamination support based on decontamination simulation for environmental restoration—testing applicability and enhancement of Decontamination Activities Support System (RESET)		
				③ Establishing proper management methods in relation to storage, etc. of removed soil, etc.		
C. Development and enhancement of bulk reduction technologies				B. Establishing proper disposal and recycling technique of waste, etc.		
① Study of appropriate processing of waste disposal which includes radioactive materials in general waste incineration facility				① Establishing proper management methods of radioactive substances, etc. in waste disposal process		
② Development of processing techniques of segregation, bulk reduction, etc. of removed soil, etc. (The research is completed)						
③ Development and enhancement of bulk reduction techniques for waste disposal, etc. which includes radioactive materials				② Developing and enhancing volume reduction technique of waste, etc. containing radioactive substances		
D. Development of control methods / appropriate handling and disposal techniques of waste disposal, etc.						
① Study of technical problems in processing of removed soil, decontamination waste disposal, etc.				(Moved to A. ③ Establishing proper management methods in relation to storage, etc. of removed soil, etc.)		
② Study of safety evaluation of temporal storage, etc. and methods to create agreement with the residents						
③ Study of behavior of radioactive cesium after the landfill of waste disposal				③ Evaluation of safety about impacts of radiation in waste disposal and treatment facilities * A part of the theme was moved to B ①		
④ Study of safety recycling of waste polluted with radioactive materials						
⑤ Establishment of appropriation technology and control methods of flow stocks in the resource recycling / waste disposal processing				④ Establishing an optimizing and managing technique of stocks and flows in process of resource circulation, and waste disposal and treatment		
⑥ Methods for appropriation and long-term control of the final disposal of low-contaminated waste disposal, etc. and temporary storage process for removed soil, etc.				⑤ Final disposal of waste with low contamination, optimization of interim storing process of removed soil, and methods of long-term storage		

[Environmental Dynamics Division]

56

Phase 1				Phase 2		
FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021
A. Interpretation of radiation migration behavior				A. Evaluation of transfer behavior		
① Research on migration behavior of radioactive nuclide in the environment				① Study for understanding actual conditions of transfer behavior of radionuclides in the environment and predicting the future dynamics		
② Research on migration behavior of radioactive cesium in forest areas and construction of environmental dynamics models				② Study regarding environmental dynamics in forest areas and transfer behavior of radioactive substance to forest product		
③ Research on migration behavior of radioactive cesium in rivers				③ Study regarding environmental dynamics in water areas and transfer behavior of radioactive substances to aquatic products		
④ Research on migration behavior of radioactive cesium in dams and ponds						
⑤ Research on migration behavior of radioactive cesium in estuaries						
⑥ Clarification of the micro behavior of micro-level amount of radioactive nuclide which controls environmental dynamics				④ Clarifying interaction of radionuclides with solid phase and mechanisms of capture, adsorption and desorption of cesium		
⑦ Evaluation of deposition behavior of radioactive cesium in the environment				(Moved to the Radiation Measurement Division)		
⑧ Dynamics clarification of radioactive cesium in watershed areas				⑤ Dynamics clarification of bioavailable radioactive cesium in watershed scale		
				⑥ Evaluation and future prospects of migration of radioactive cesium to organisms		
B. Radioactivity migration models				B. Transfer models		
① (Republished) Research on migration behavior of radioactive nuclide in the environment				(Integrated in ① Study for understanding the migration behavior of radionuclides in the environment and predicting the future dynamics)		
② (Republished) Research on migration behavior of radioactive cesium in forest areas and construction of environmental dynamics models				① Developing dynamics models in land and water		
③ Development of migration analysis model of radioactive cesium in rivers, dams, ponds and estuaries						
④ Development of soil erosion analysis models for wide areas in Fukushima prefecture				② Environmental modeling of multiple media in basin areas		
⑤ Multimedia environmental modeling in watershed areas						
(Partly moved from the Radiation Measurement Division)				③ Developing the comprehensive evaluation system to perform evaluation of impacts on environments of Fukushima		
C. Understanding of radiation influence on wild animals				C. Evaluation of influence on ecosystems		
① Study of behavior and behavior prospects of radioactive nuclide in wild animals				① Study about impacts of the nuclear power station accident on wild animals		
② Evaluation of the influence of radiation, etc. on organisms				② Evaluating impacts of radiation, etc. on wildlife organisms		
D. Methods to control ecosystems, etc.				③ Studies on evaluation and restoration of ecosystems		
① Field survey of the ecosystem and landscape change						
② Recovery research of the ecosystem which is disturbed						

[Environmental Creation Division]

57

