

Fukushima: The impact on the environment and public health

Overview

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Mourn for Victims

We would like to express our mourn for victims of earthquake, tsunami and NPP accident.
: around 20,000 death.

We would like to express our appreciation for the support of Japan from all over the world.

Acknowledgement :
for the Arrangement of this session by IRPA.

Great East Japan Earthquake

14:16, March 11, 2011

Magnitude 9.0

More than twenty thousands

Death and missing people

More than forty hundreds of
thousands Evacuees



津に押し寄せて家屋をのみ込む大津波
=11日午後3時55分、名取市

津波

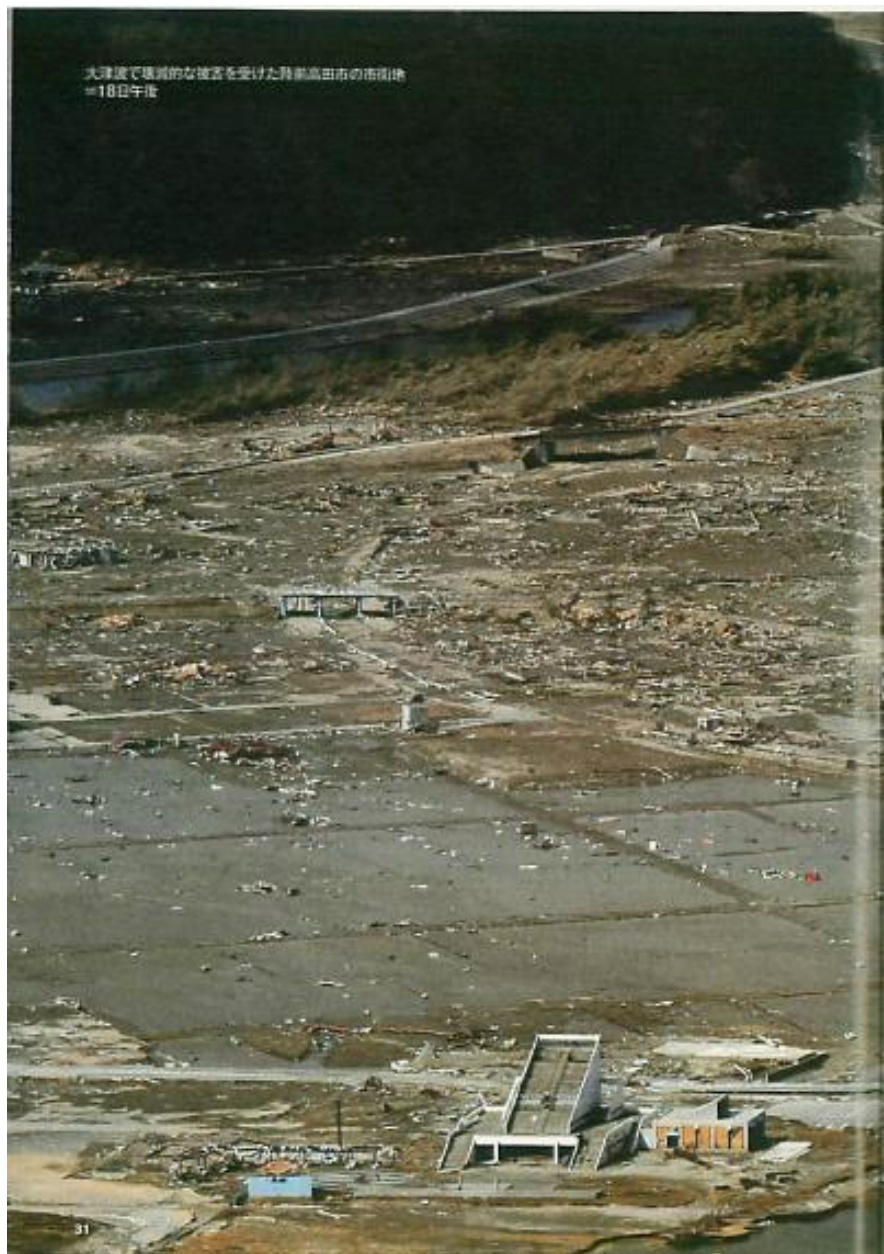


大津波が宮古市を襲った瞬間。車はほとんど簡単に国道106号に打ち寄せられた
—11日午後3時25分ごろ、宮古市新川町（宮古市職員提供）



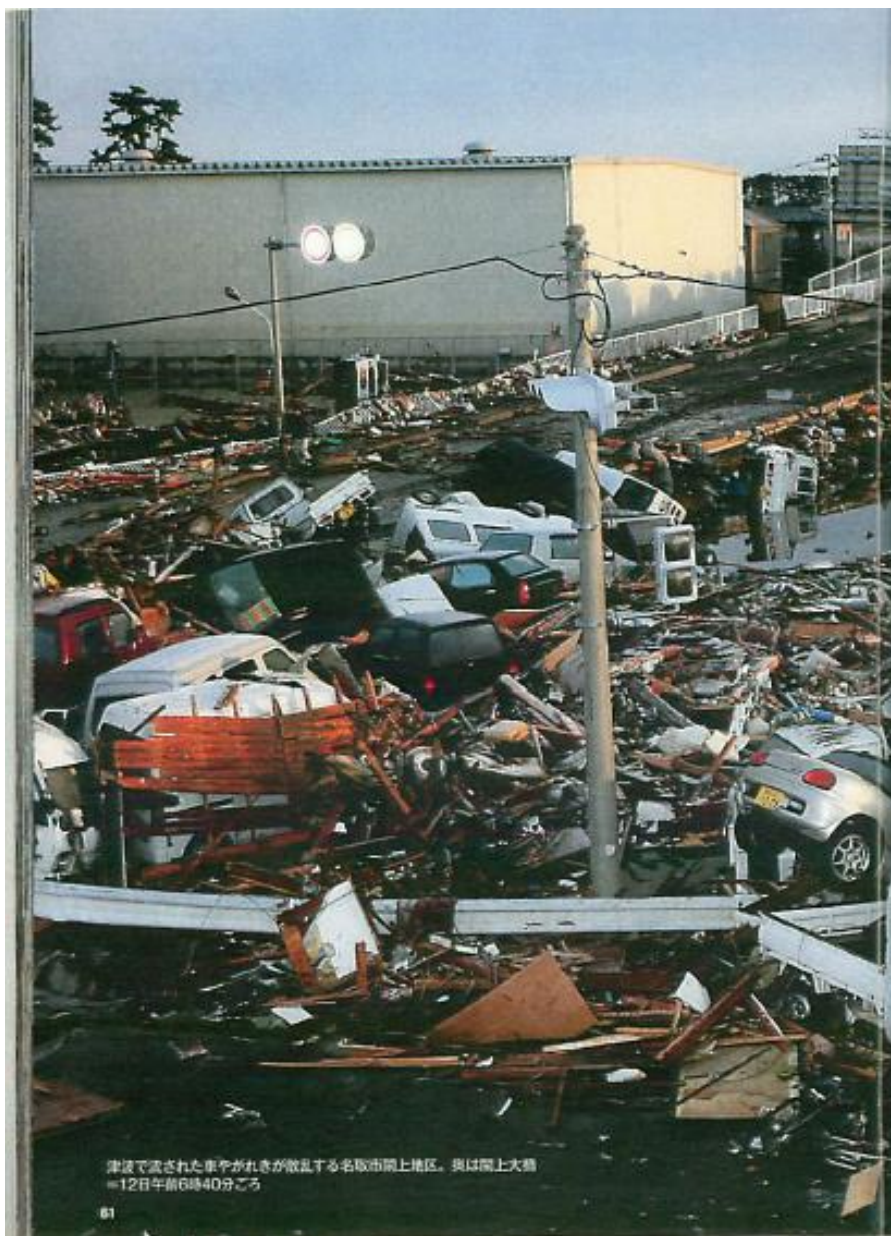
まるで戦争の跡のような惨状が広がった石巻市南浜町
=13日午前9時30分ごろ

大津波で壊滅的な被害を受けた舞鶴高田市の市街地
＝18日午後



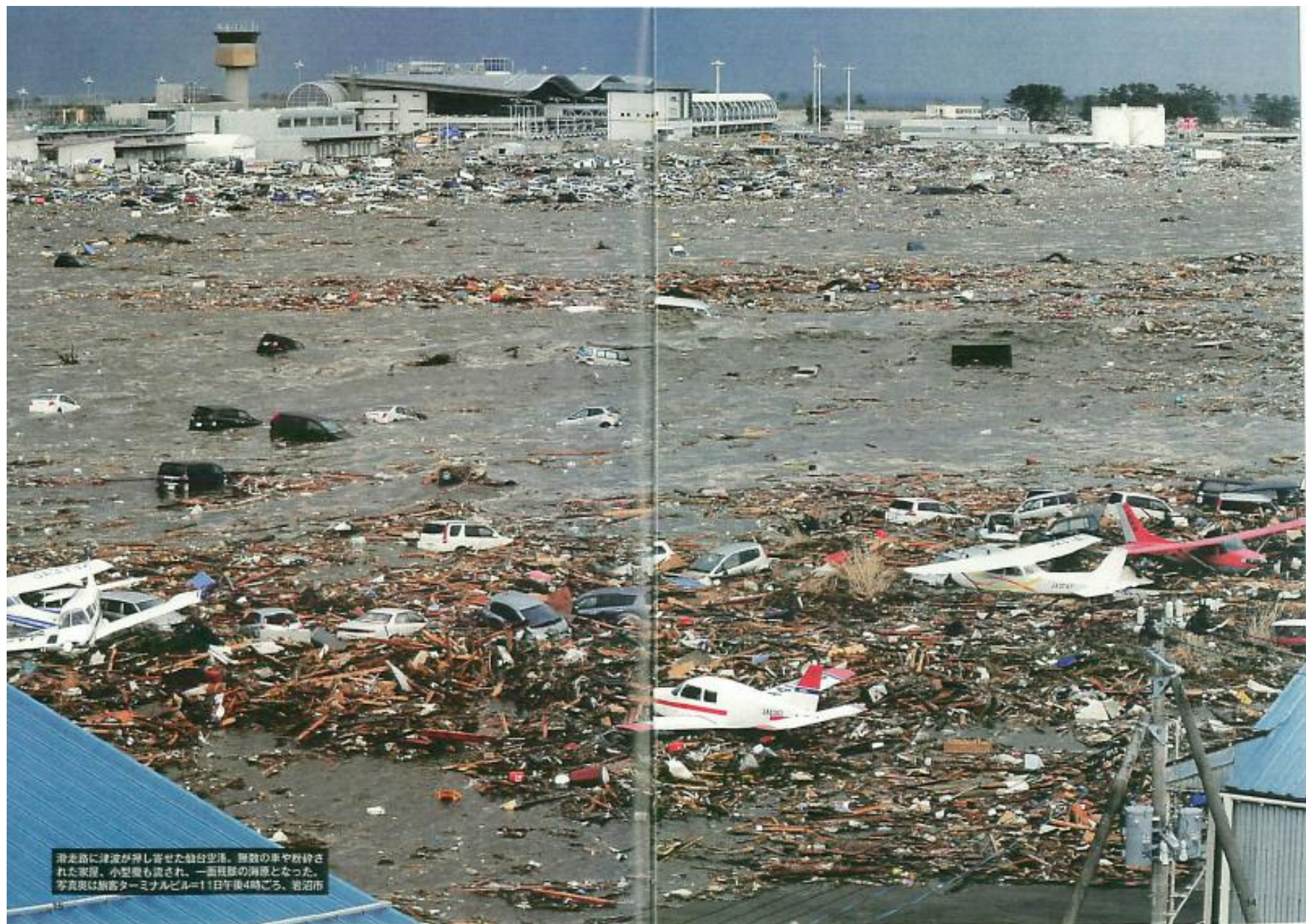


商店街に船が、一帯がいったん海と化したことを物語る
＝12日午前7時ごろ、石巻市中央2丁目

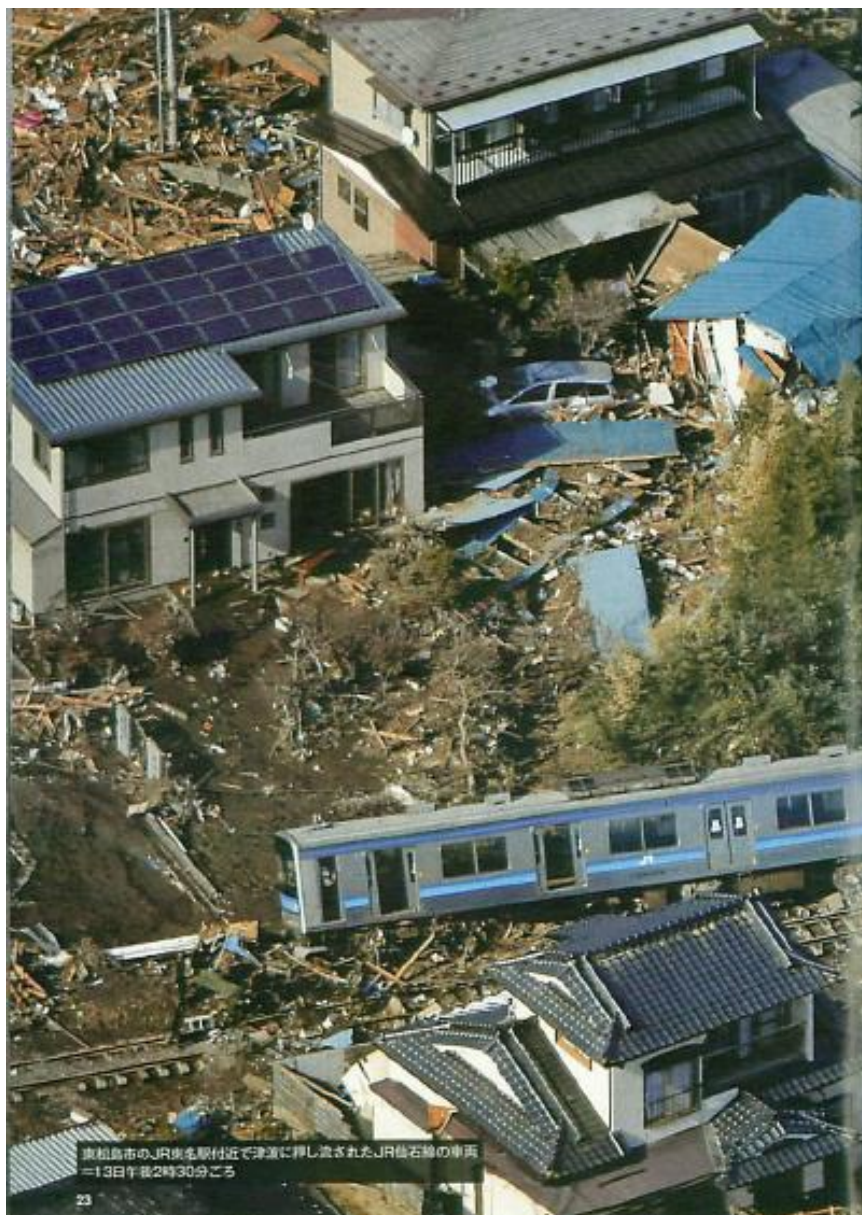


津波で流された車ががれきが散乱する名取市岡上地区。奥は岡上大橋
 12日午前6時40分ごろ

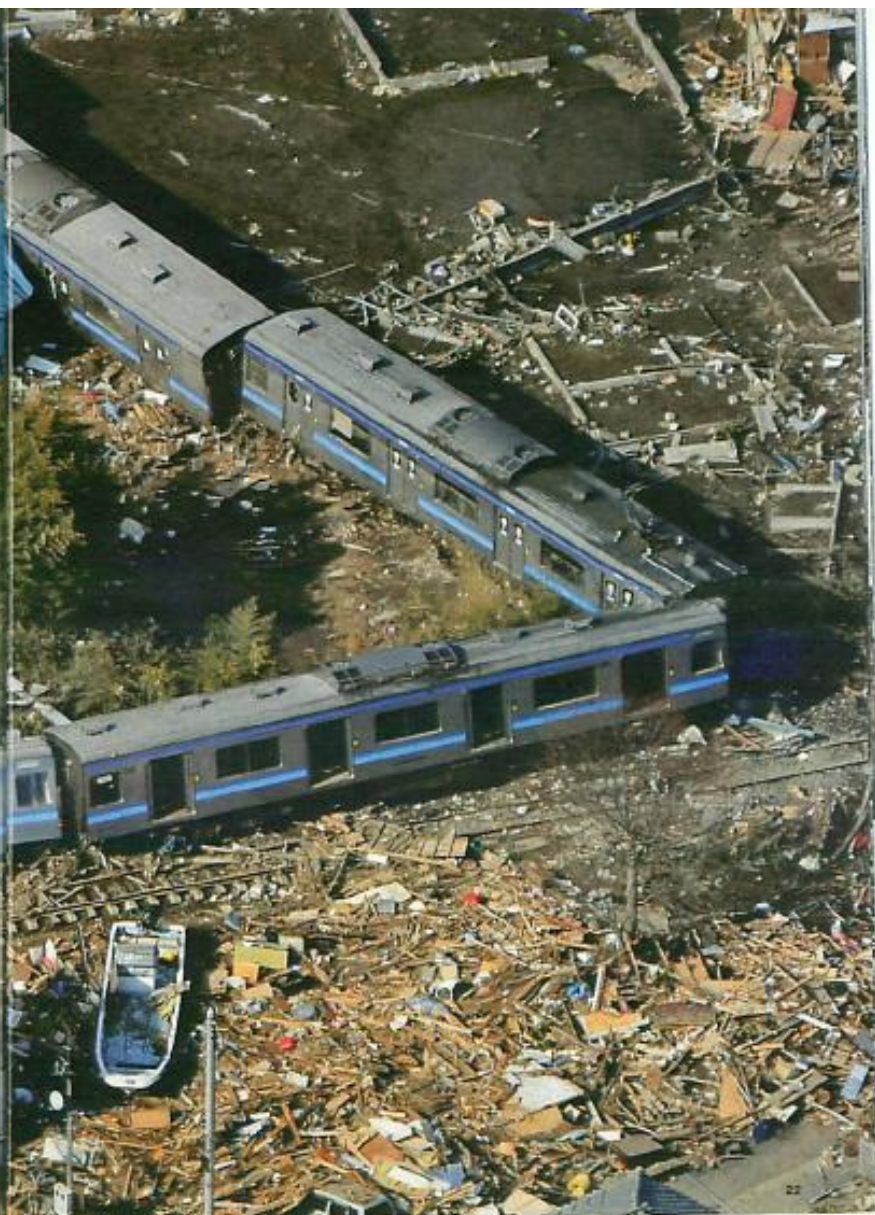


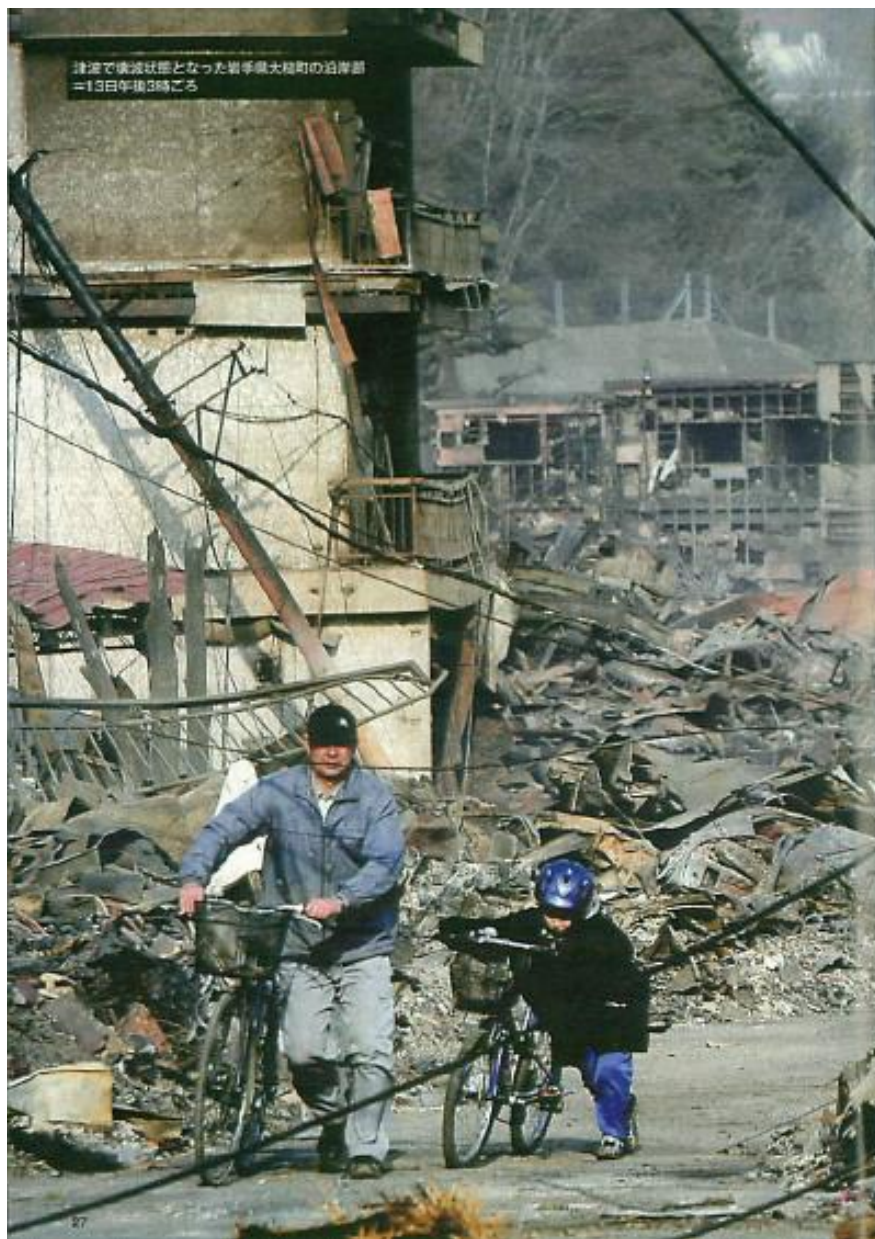


滑走路に津波が押し寄せた仙台空港。無数の車や粉砕された家屋、小型機も流され、一面瓦礫の海原となった。写真奥は旅客ターミナルビル＝11日午後4時ごろ、岩沼市



東松島市のJR東松島駅付近で津波に押し流されたJR仙石線の車両
=13日午後2時30分ごろ

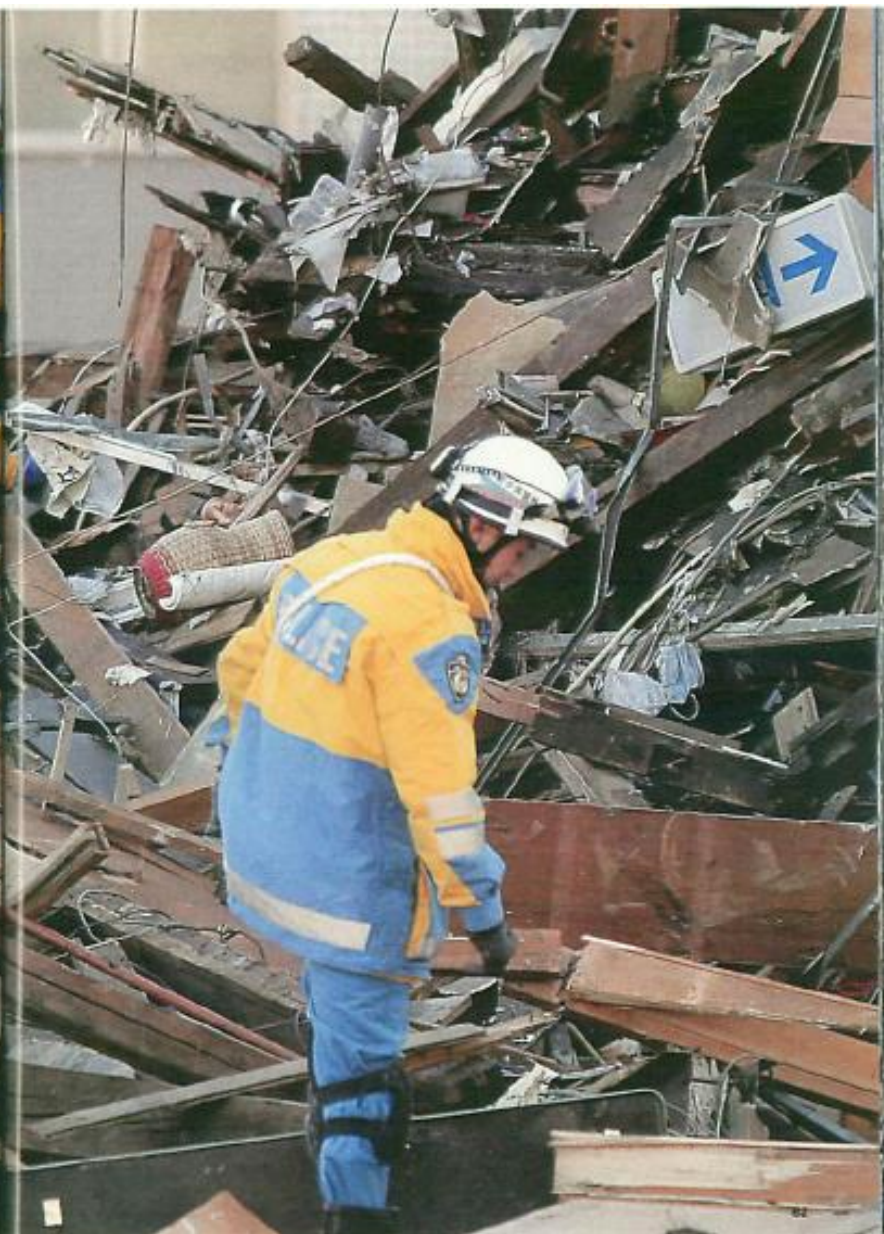
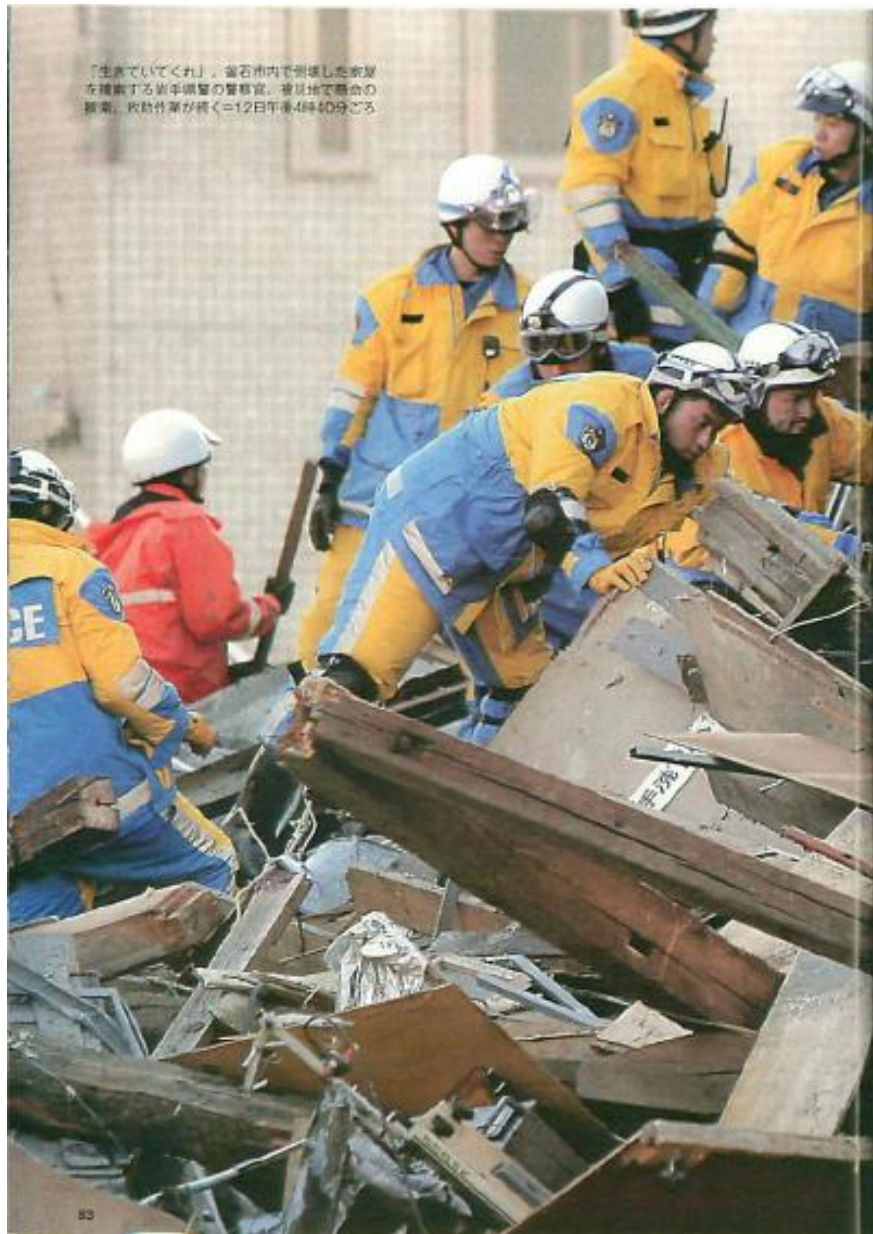


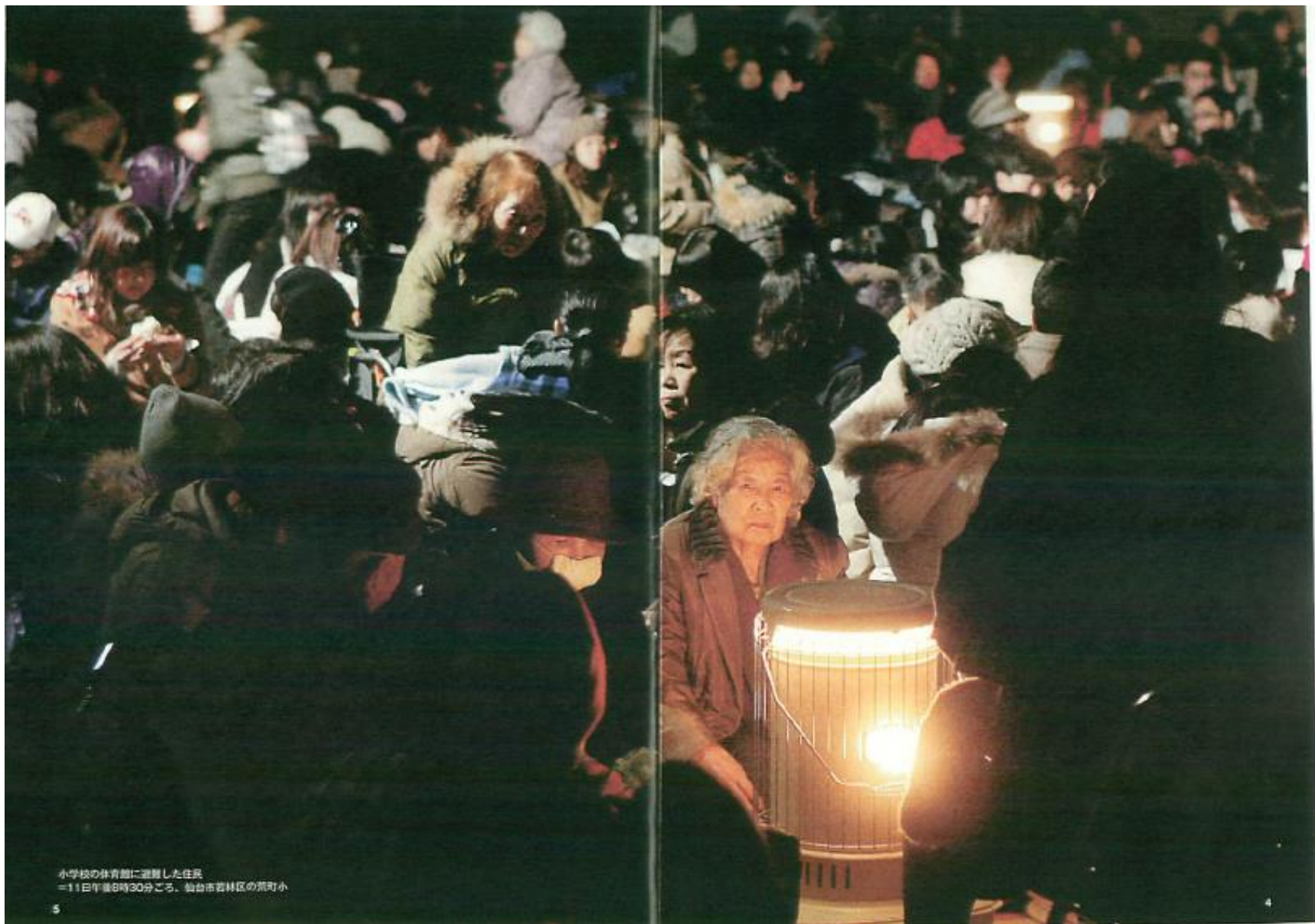




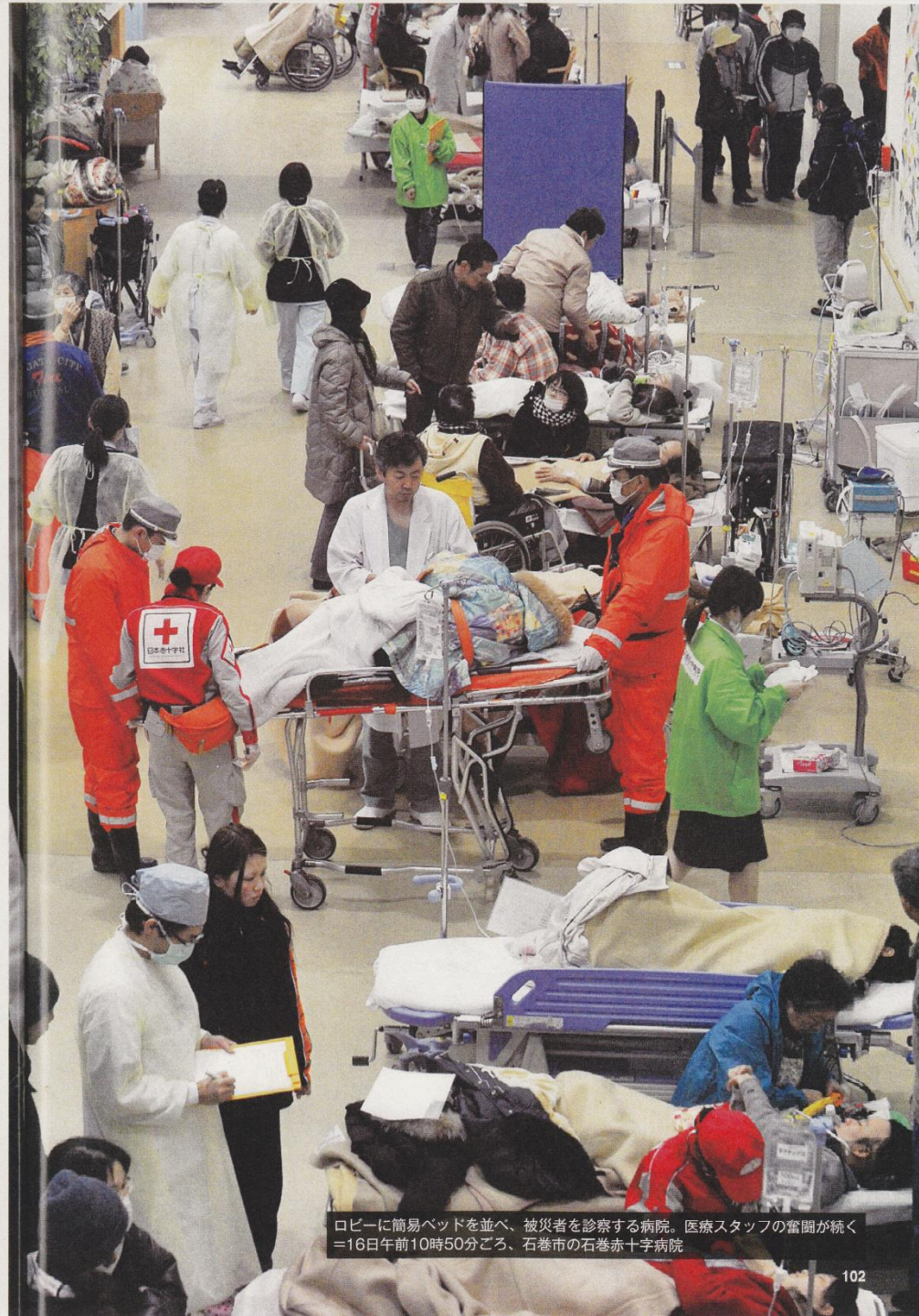
自衛隊のヘリコプターで救出される被災者
=13日午後2時ごろ、石巻市中里

「生きていてくれ」、釜石市内で倒壊した家屋を捜索する岩手県警の警察官。被災地で懸命の捜索。救助作業が終く＝12日午後4時40分ごろ





小学校の体育館に避難した住民
=11日午後8時30分ごろ、仙台市若林区の荒町小



ロビーに簡易ベッドを並べ、被災者を診察する病院。医療スタッフの奮闘が続く
=16日前10時50分ごろ、石巻市の石巻赤十字病院



遺体安置所となった宮城県利府町のグランディ21で遺族の迎えを待つ震災犠牲者＝18日午前11時15分ごろ

原発



東京電力福島第1原発3号機に放水する自衛隊の消防車=18日午後、福島県大熊町（陸上自衛隊中央特殊武器防護隊撮影、防衛省が19日に公開）

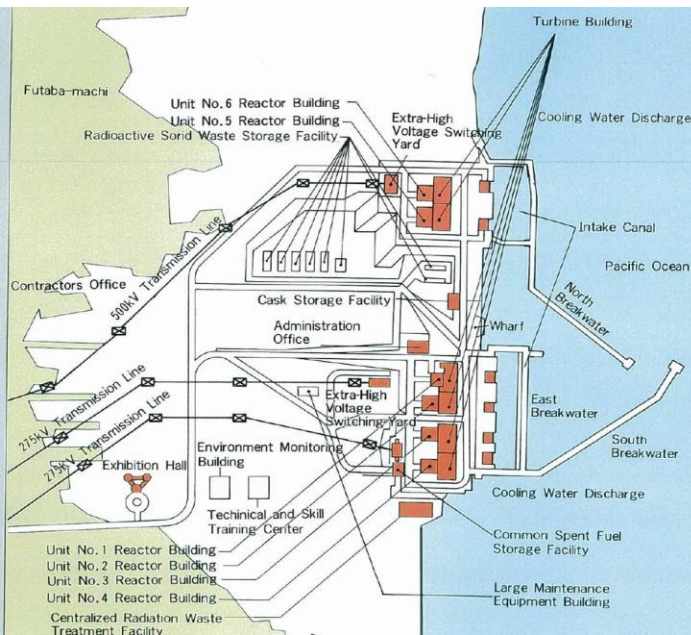
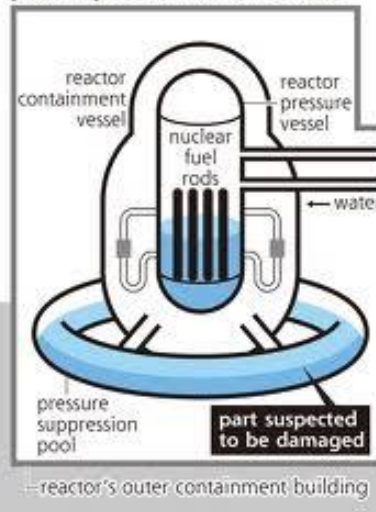


白煙を上げる東京電力福島第1原発3号機（左）。中央奥は4号機=15日（東京電力提供）

Fukushima-Dai-ichi NPP accident

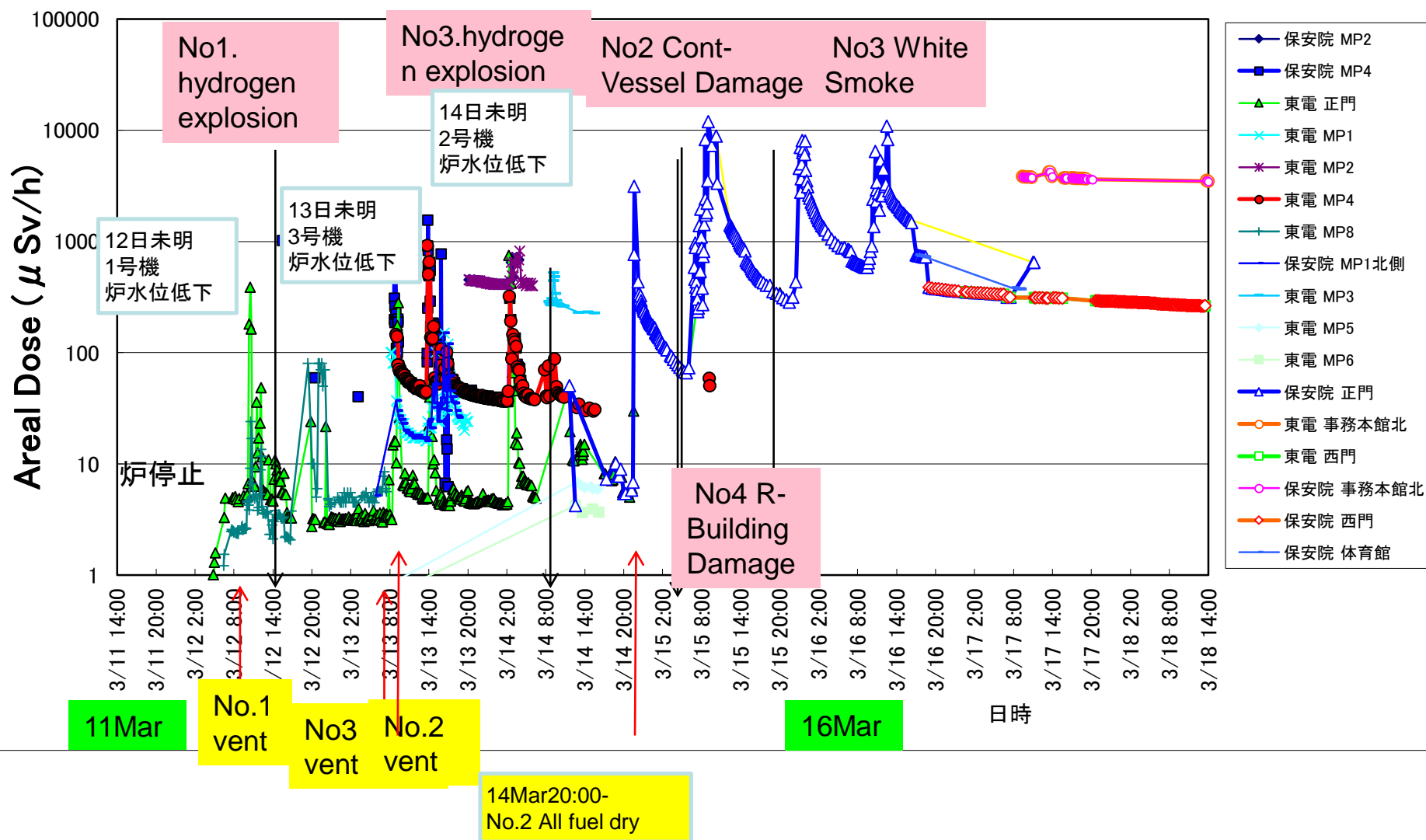


Fukushima No. 1 nuclear power plant's No. 2 reactor



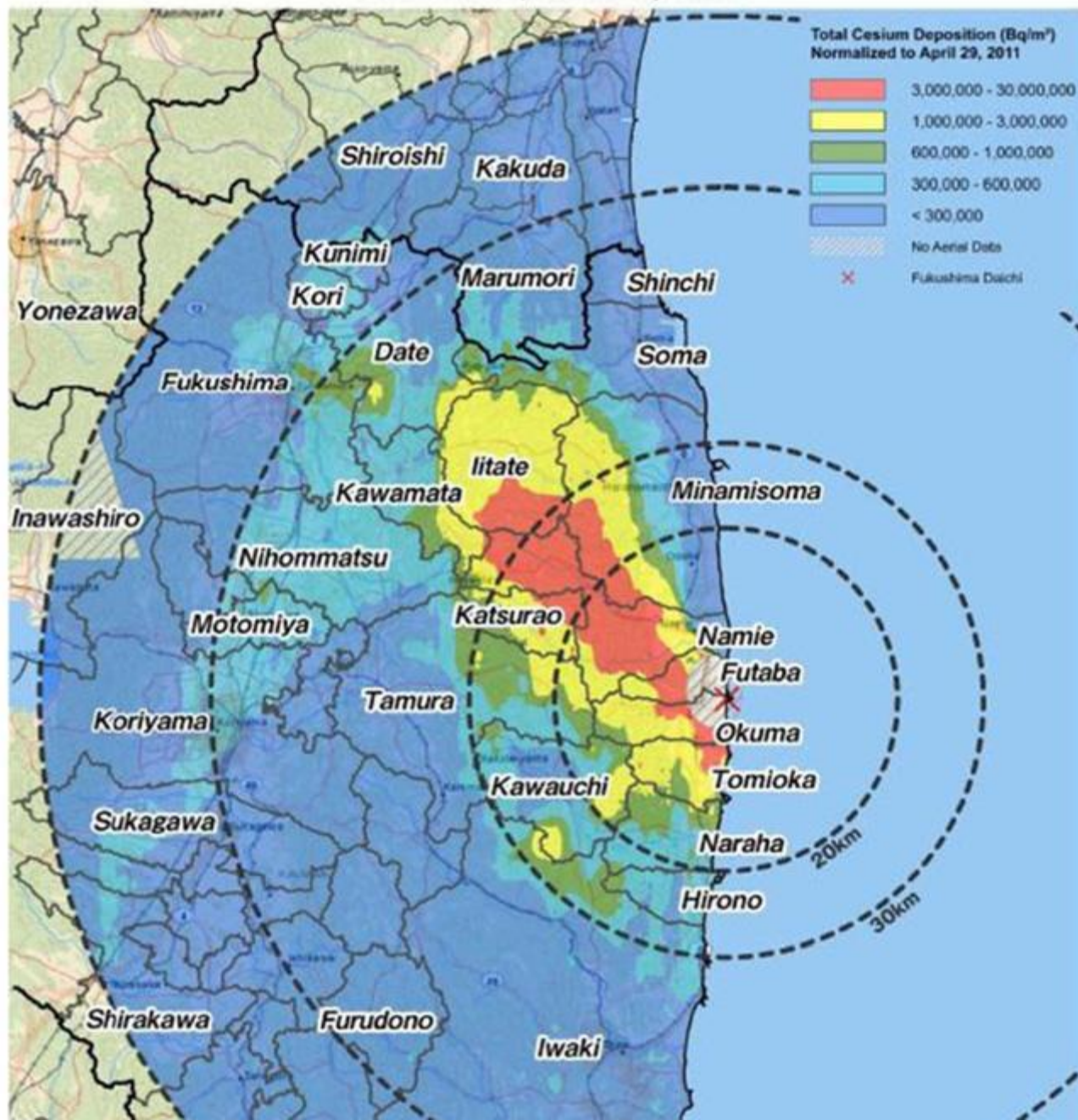
Release of Radioactivity from Fukushima No.1 NPP

Areal dose around Fukushima 1 nuclear power plant (NISA, TEPCO)



Aerial Measuring Results

Joint US / Japan Survey Data



What happened in Fukushima?

✓ Extraordinary large external event

Earthquake (Magnitude 9.0), Tsunami (20m)

Station blackout > Core melt down

✓ EPZ (Emergency Preparation Zone)

2km radius > 5km > 10km > 20km : 1-2 days

✓ Off-Site Center (Substantial Center)

Government + Local G. + NPP + Media

The distance, around 5km

Earthquake, Tsunami > damage

Radiation plume, High radiation dose > can't use

Move to Fukushima prefectural capital (100km)

What happened in Fukushima?

✓Reactor

Coolant supply, Emergency workers (Dose limit)
Firemen, soldier etc.

✓Environment

Emergency monitoring, Huge number of data,
Information sharing, Struggle between organization

✓Inhabitants

Delivery of information, Iodine pill application,
Collection of corpses, Domestic animals and
house pets

✓Mass media and general public

Bashing and sensational, > impact to the Cabinet,
NISA, MEXT, NSC, Local Gov.

What happened in Fukushima?

- ✓ Early stage countermeasure

 - Too much insist of 100mSv

 - Food control

- ✓ Middle period countermeasure

 - Too much insist of 20mSv

 - Decontamination (>Cleanup) of environment

 - Food control

- ✓ Long term countermeasure

 - Risk communication, Children's problem,

 - Compensation of the disasters

 - Environment, forest, farmland reform

- ✓ Rebuilding of the safety department

 - Joining of NISA, NSC and others

 - Positioning of the Nuclear Power Plants in electric supply

A state of confusion after the accident

Event

Sheltering and
Evacuation

Termination of the
Declaration of
Emergency

Food and Drink
Control

Influence on
public health

Reasons

- Future step is unclear, even a week later
- Engagement of the Government, awkward
- Role of the local Government, awkward

- Termination procedure is unclear

- Permitted level of food?, Reasonability?
Flexibility?
- pollution level for planting soil
- pollution of seawater for marine products

- Accurate dose estimation of residents
- Uncertainty of low dose health effect to man

Dose Limitation for Emergency Workers

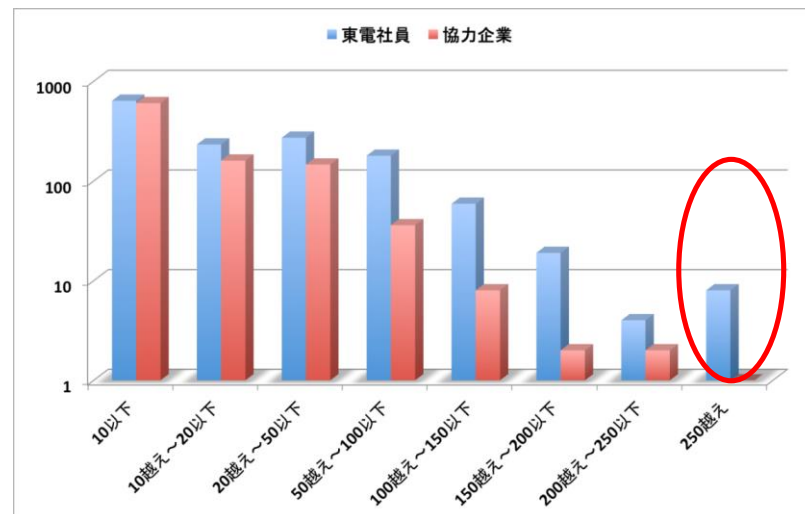
Details

- Japanese regulation; 100 mSv
- Submitted a question of limitation change from 100 to 250 mSv to Radiation Protection Board for deliberation. (March 14).
Approved in a short time (2hours) by NRC.
- On March 26, Industrial Minister declared a new value of 250 mSv for emergency worker's dose limit.



Problem

- + About 500 mSv is Recommended by ICRP and IAEA.
- + Japanese Radiation Protection Board has already summarized a recommendation to change to a new value of 500 mSv by following ICRP. (January, 2011)
(The intermediate report on the introduction of a new radiation protection system of ICRP-103 (2007 Recom.) to Japanese regulatory system is opened in the home page of the government.)
- + The harmonization between the International guide and Japanese one is an important issue.



Workers' Dose, June 13, 2011, Press release by Tokyo Electric Co.

Setting of Evacuation Area

- Details

- Application of 20 mSv/year

- Planned evacuation area:

Lower value among 20-100 mSv/y reference level at emergency exposure situation by ICRP Pub. 103 (2007 recommendation).

- On the other hand, same 20 mSv/y was applied as a guide for use of school ground, which was an upper value of reference level of 1-20 mSv/y in an existing exposure situation



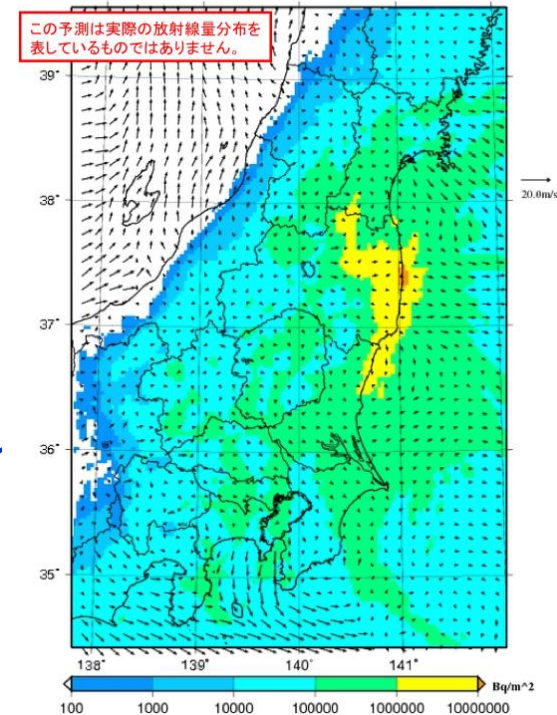
Prediction of Radionuclide Diffusion at a Nuclear Emergency

- Details

- Worse Use of System for Prediction of Environmental Emergency Dose Information ([SPEEDI](#))
 - The hard case to determine the **source term** of radionuclide release
 - No use of SPEEDI result to use an emergency countermeasure for the dose reduction of refugee exposure
- **Information opening to the public** by foreign organizations
 - Weather authorities or nuclear authorities, in Germany, UK, France, Austria etc.

ヨウ素131の表面沈着量(平成23年3月25日 0時現在) 積算値

Surface deposition of I-131 at UTC= 2011-03-24_15h



Deposition of I-131
(00:00, March 25, 2011)

Processing and Disposal of Wastes after the Disaster



Details

--Tentative guidance By Nuclear Safety Commission (NSC) June 3, 2011

- 10 $\mu\text{Sv/y}$, for recycle and reuse goods
- 1 mSv/y, workers for collecting, transportation and storage.
- 1 mSv/y, workers for waste processing
- Disposal facility, dose for surrounding residents after the facility closure
 - 10 $\mu\text{Sv/y}$ on basic scenario
 - 0.3 mSv/y on variation scenario

– Basic concept “Policy on the disaster waste treatment in Fukushima Prefecture”, by Environment Ministry , June 23, 2011

- Presupposition: “Guarantee of the Safety “
 - of workers and surrounding residents for the operation of incineration plants and final disposal facilities
- If in case of no satisfaction of the guidance by NSC:
 - After taking an appropriate temporal storage, the regulatory authority should immediately investigate a safety disposal measure

Control of Contaminated Foods and Drinks

- Details
 - Intervention Level on the Intake Limitation of Foods and Drinks



Pile of returned Spinach to Scrap
(Tokyo Central Wholesale Market,
March 23)

- + Thyroid Equivalent Dose by Radio-Iodine : **50 mSv**
 - Specific iodine deposition to thyroid
- + Effective Dose by Radio-Cesium : **5 mSv**

ICRP Pub. 40
(1984)

	Committed Dose (mSv/y)	
	Effective Dose	Equivalent Dose (Each Organ)
Upper Dose Level	50	500
Lower Dose Level	5	50

Radiation level judgment on the use of school buildings and grounds in Fukushima Prefecture



www.sciencemag.org **SCIENCE** VOL 332 20 MAY 2011
Published by AAAS

- **Details**

- Application of 1-20 mSv/year

- (Ministry of Education notification on April 19)

- Based on ICRP Publ.109

- (exposure situation in the emergency)

- CRP Publ.109 (**Emergency** Exposure Situation)

- Application of Reference level 20-100

- (lower value of 20 mSv/year)

- Changed to Publ.103

- (Reference level on a **Restoration**,
upper value of 20 in 1-20 mSv/y)

- Regular ground use is possible below 3.8 μ Sv/h.

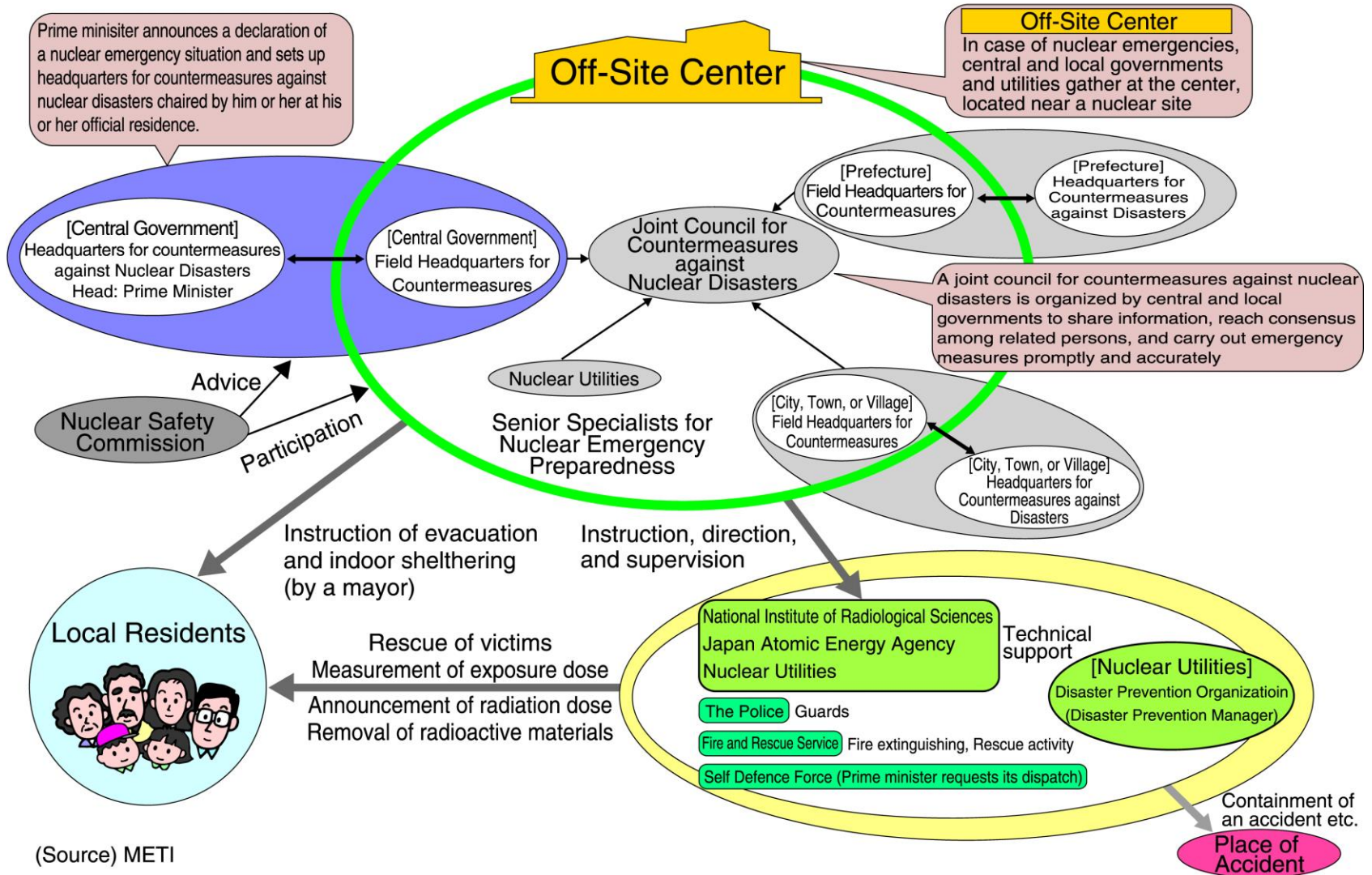
- (Derived from 20mSv/y including occupancy factor)

Principles of Radiation Protection

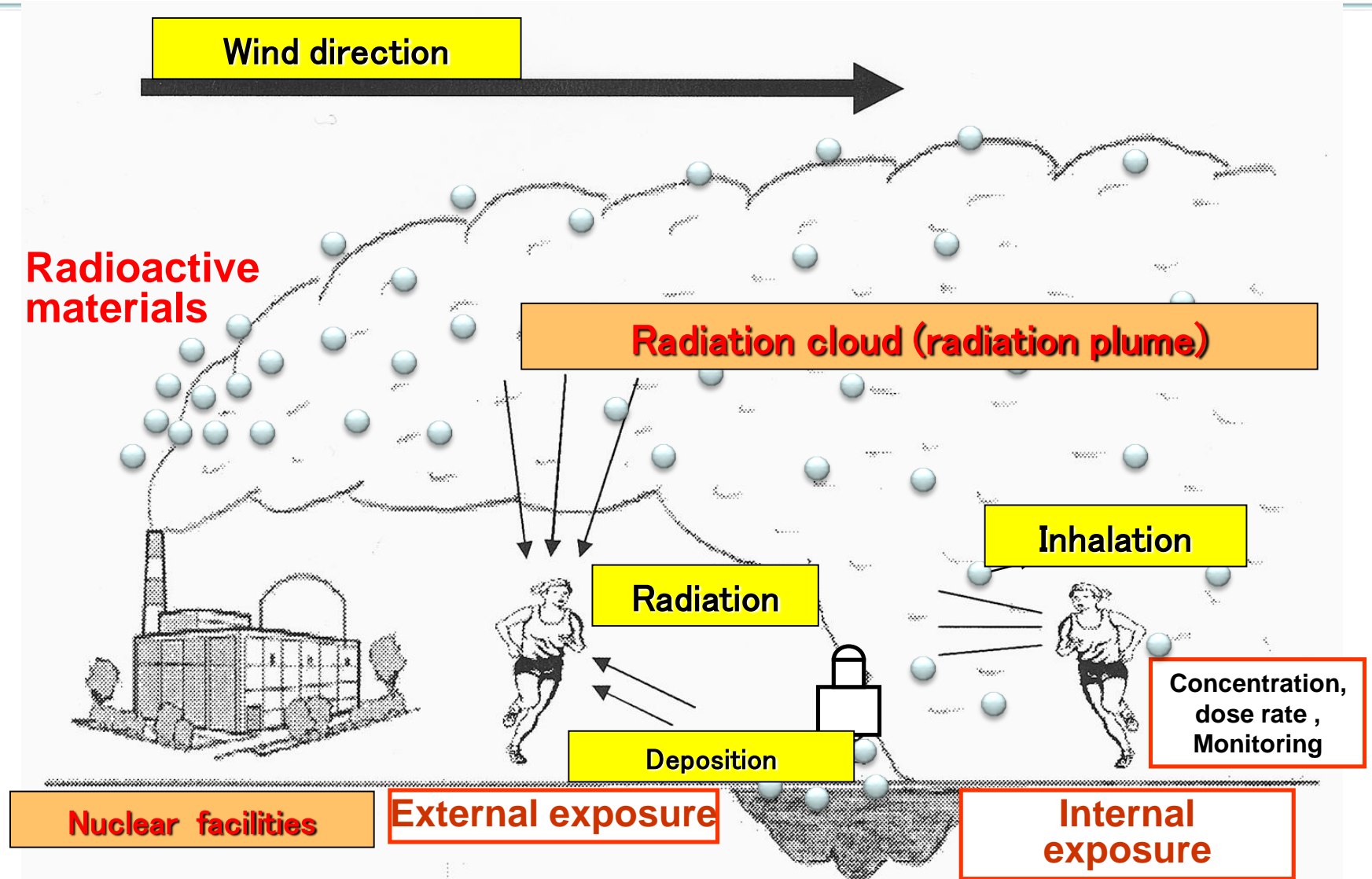
Emergency preparedness for nuclear accident

Disaster Prevention Systems during Nuclear Emergencies

[If abnormalities occur, central and local governments and utilities are united and take measures]



Conceptual figure of exposure by radiation plume



Countermeasure

- ① **Sheltering**
- ② **Sheltering to concrete building**
- ③ **Evacuation**
- ④ **Application of stable iodine**
- ⑤ **Control of drinking water, milk and food**
- ⑥ **Restriction of entry**

Evacuation and sheltering

Sheltering



Evacuation



Sheltering to the Concrete Building

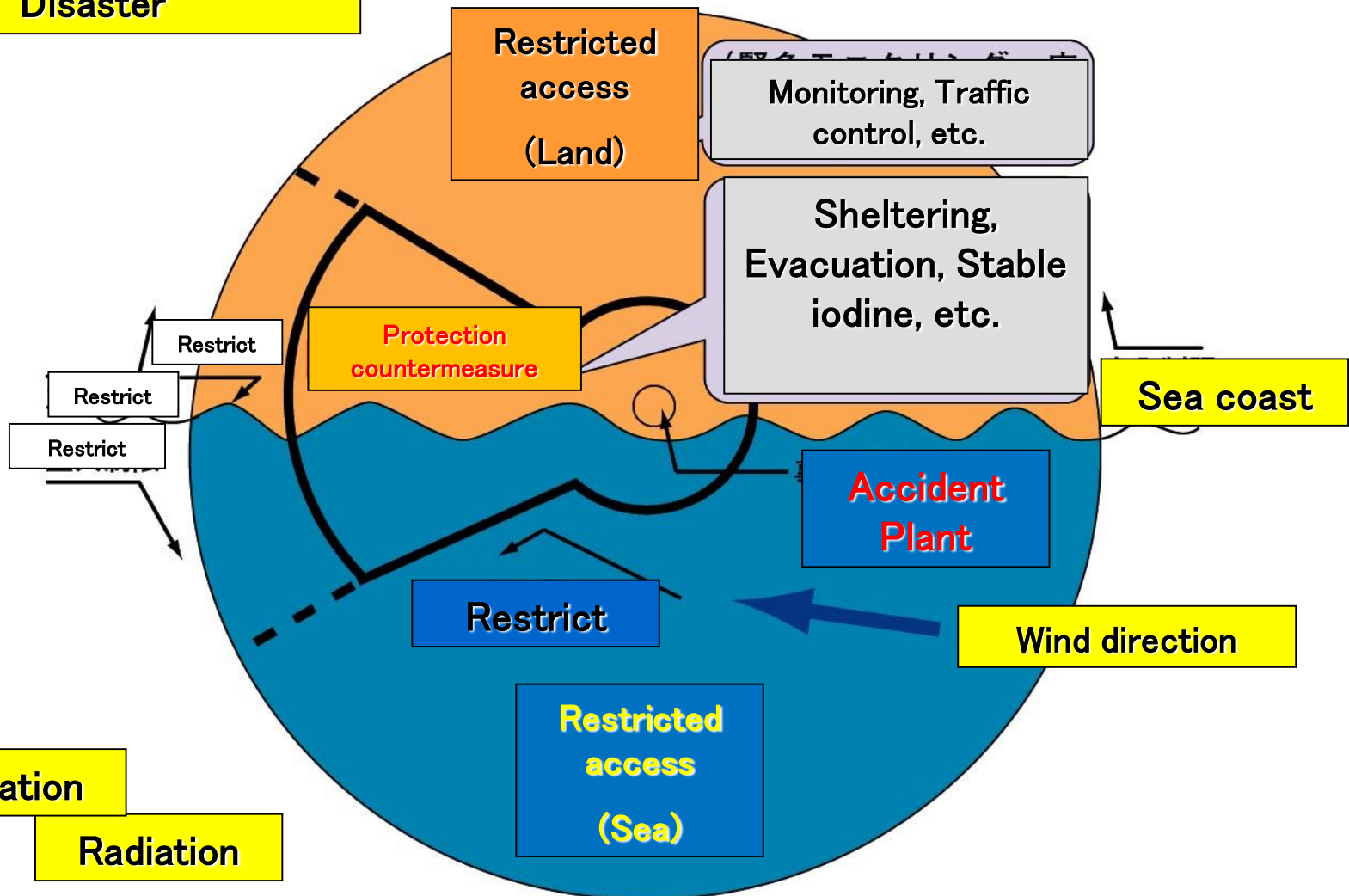


Reduction of iodine plume

Building type	Reduction rate
○ Airtight Building	$1/20 - 1/70$
○ Normal building	$1/4 - 1/10$

Example of countermeasure area and access restricted area

Guideline of Pretension of Disaster



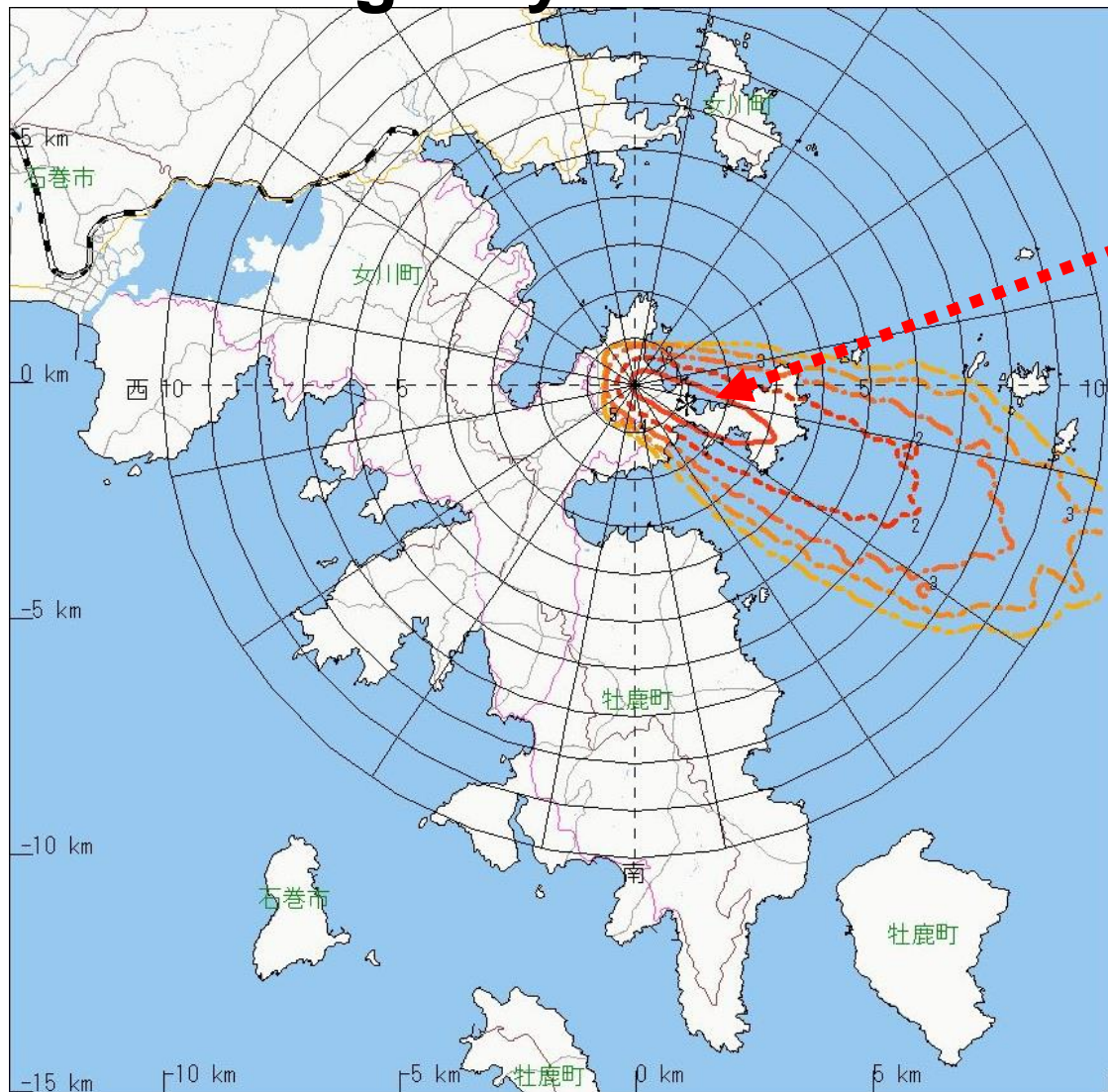


SPEEDI

SPEEDI

(System for Prediction
of Environmental Emergency Dose Information)

(1) Monitoring support in case of Emergency

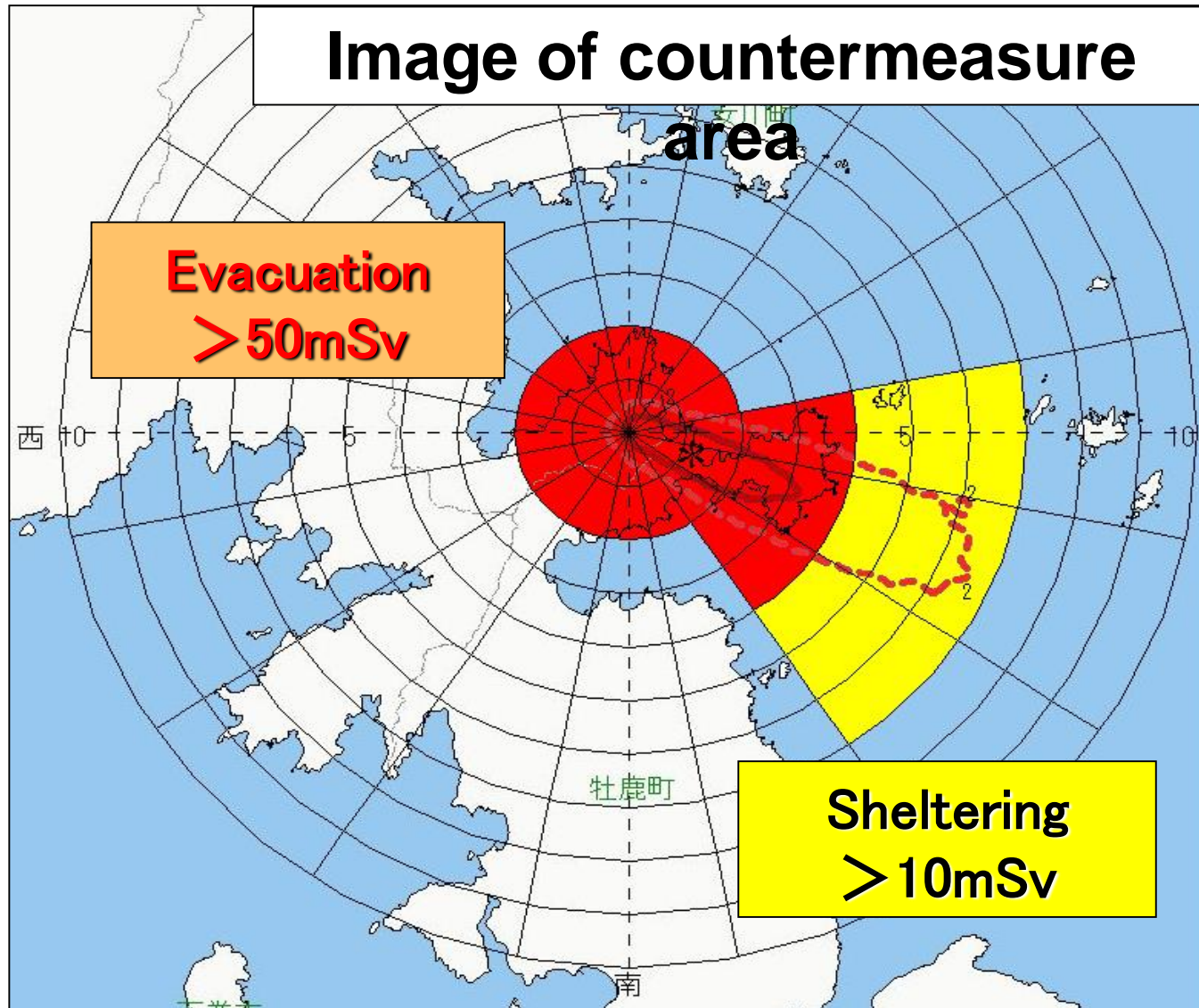


Monitoring car

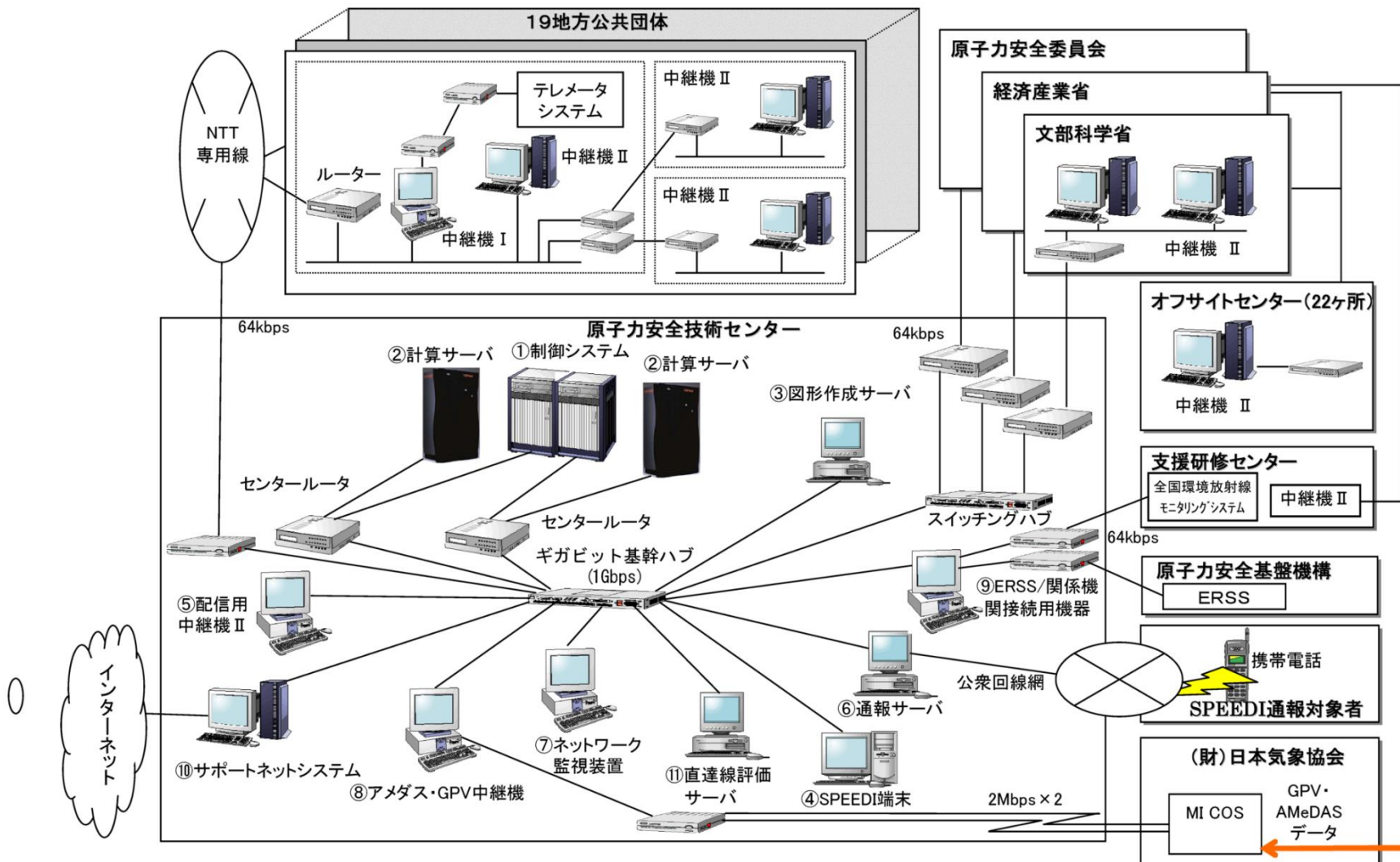


Survey meters

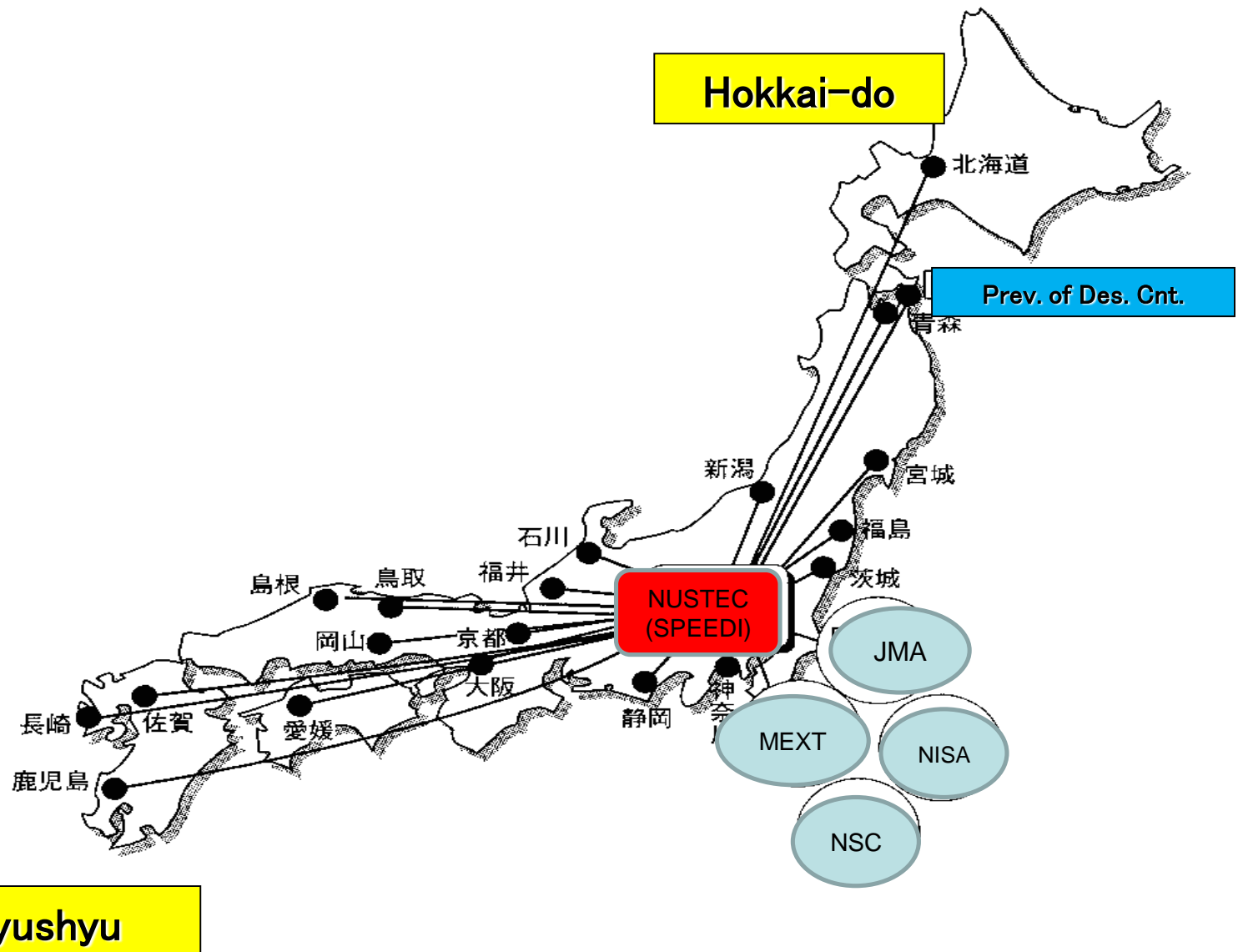
(2) Planning of the countermeasure



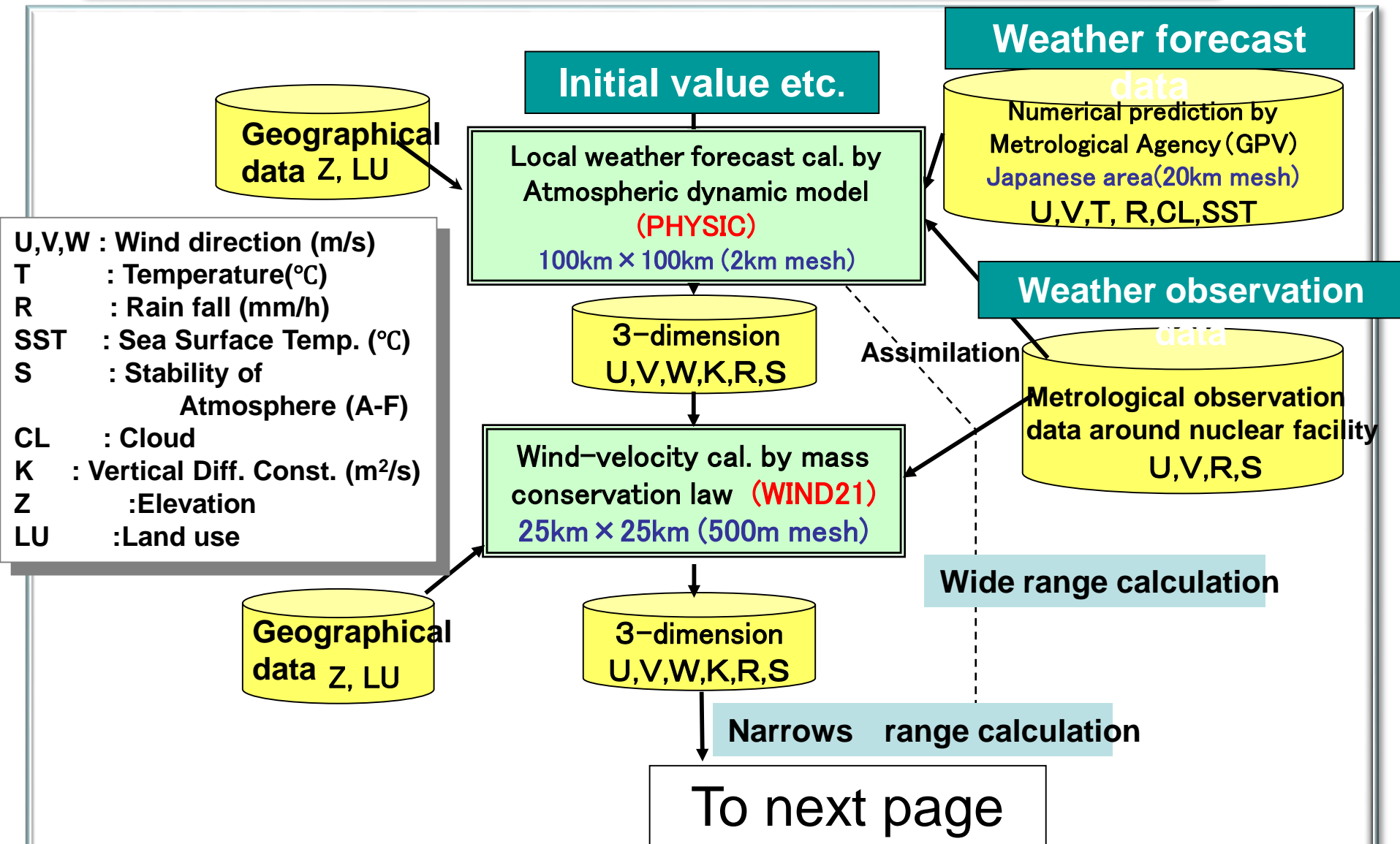
Construction of SPEEDI System



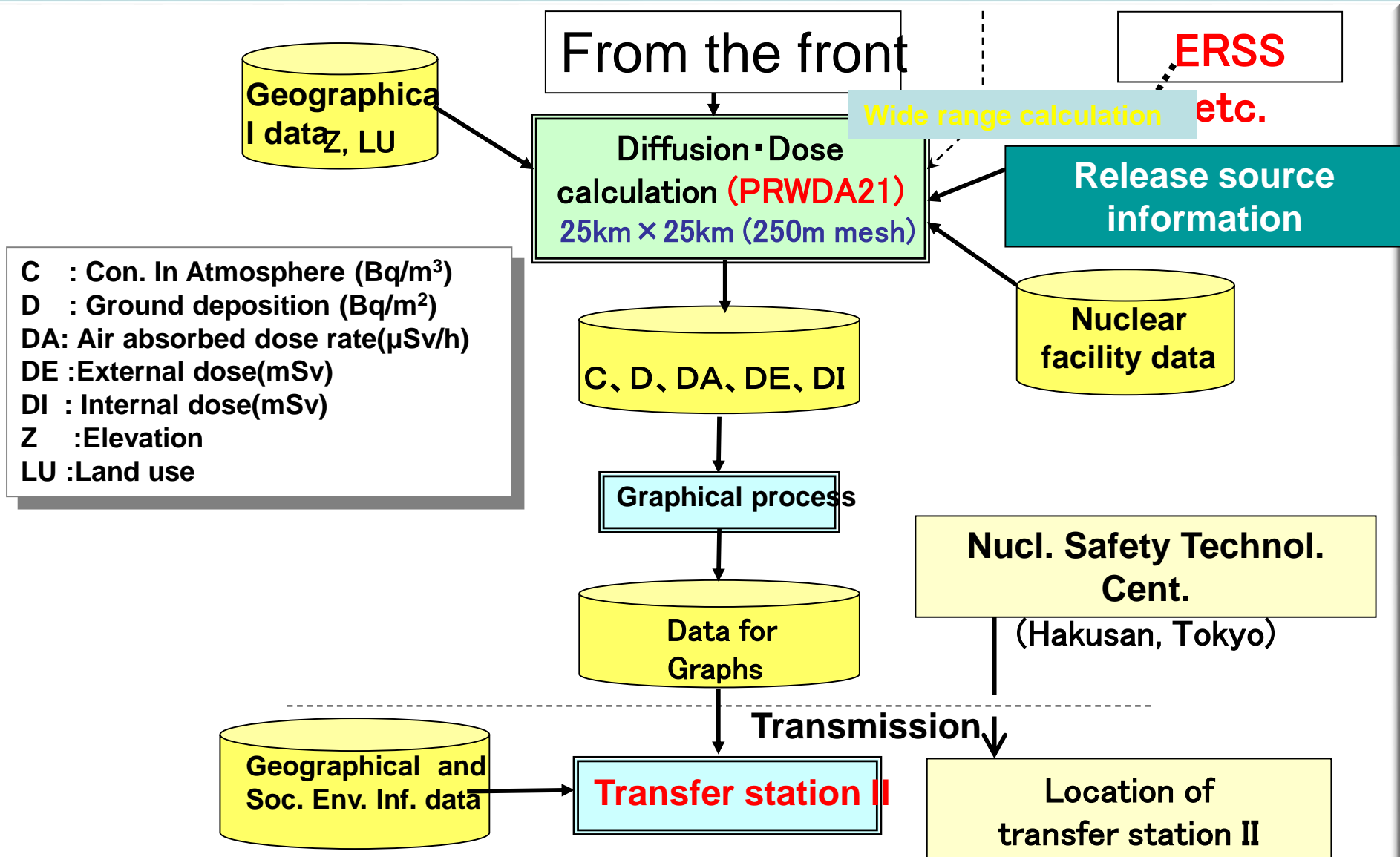
Data communication network by SPEEDI System



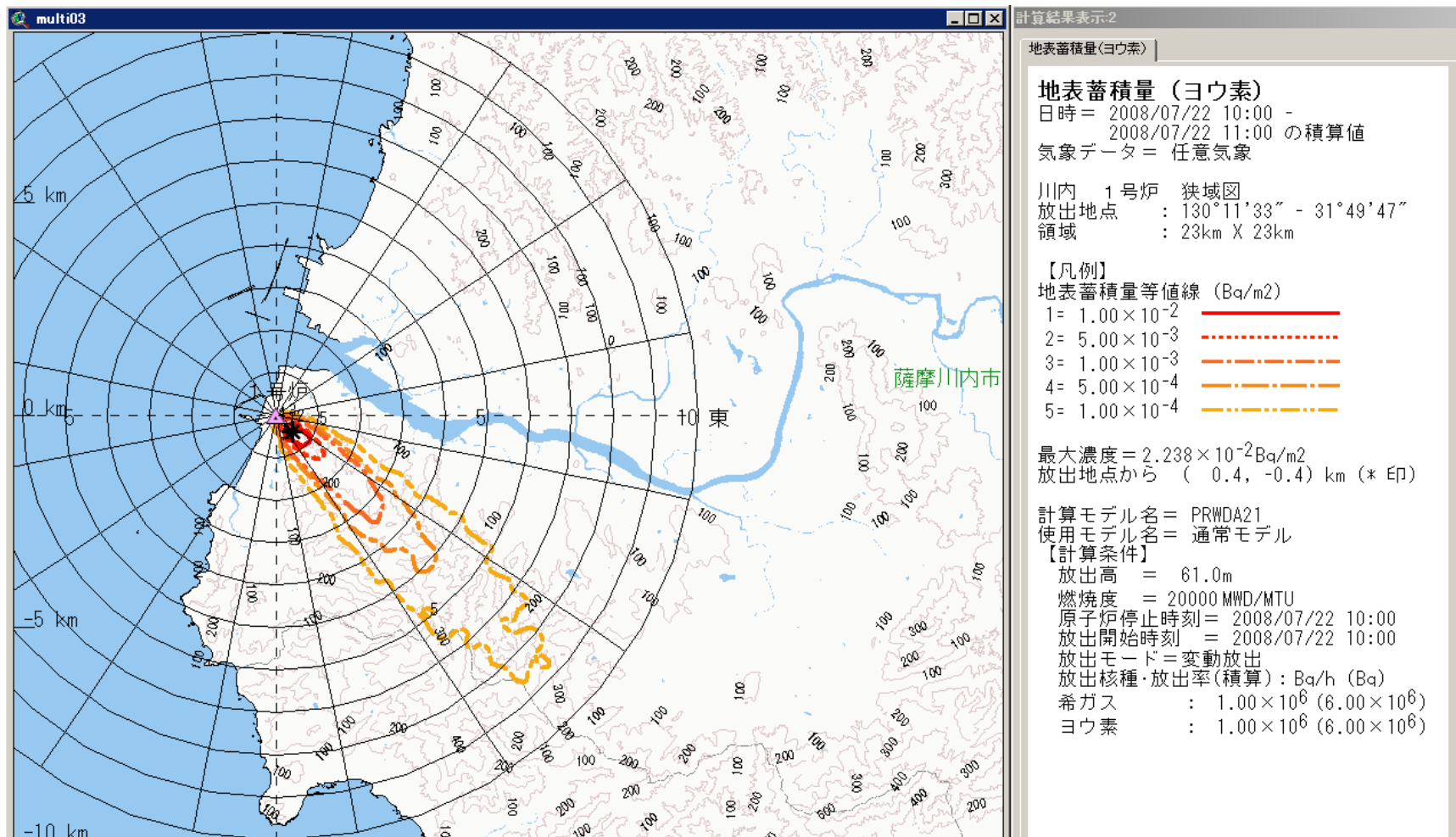
Calculation flow of SPEEDI(1/2)



Calculation flow of SPEEDI (2/2)



Out put of figures ■ Surface accumulation dose by deposition

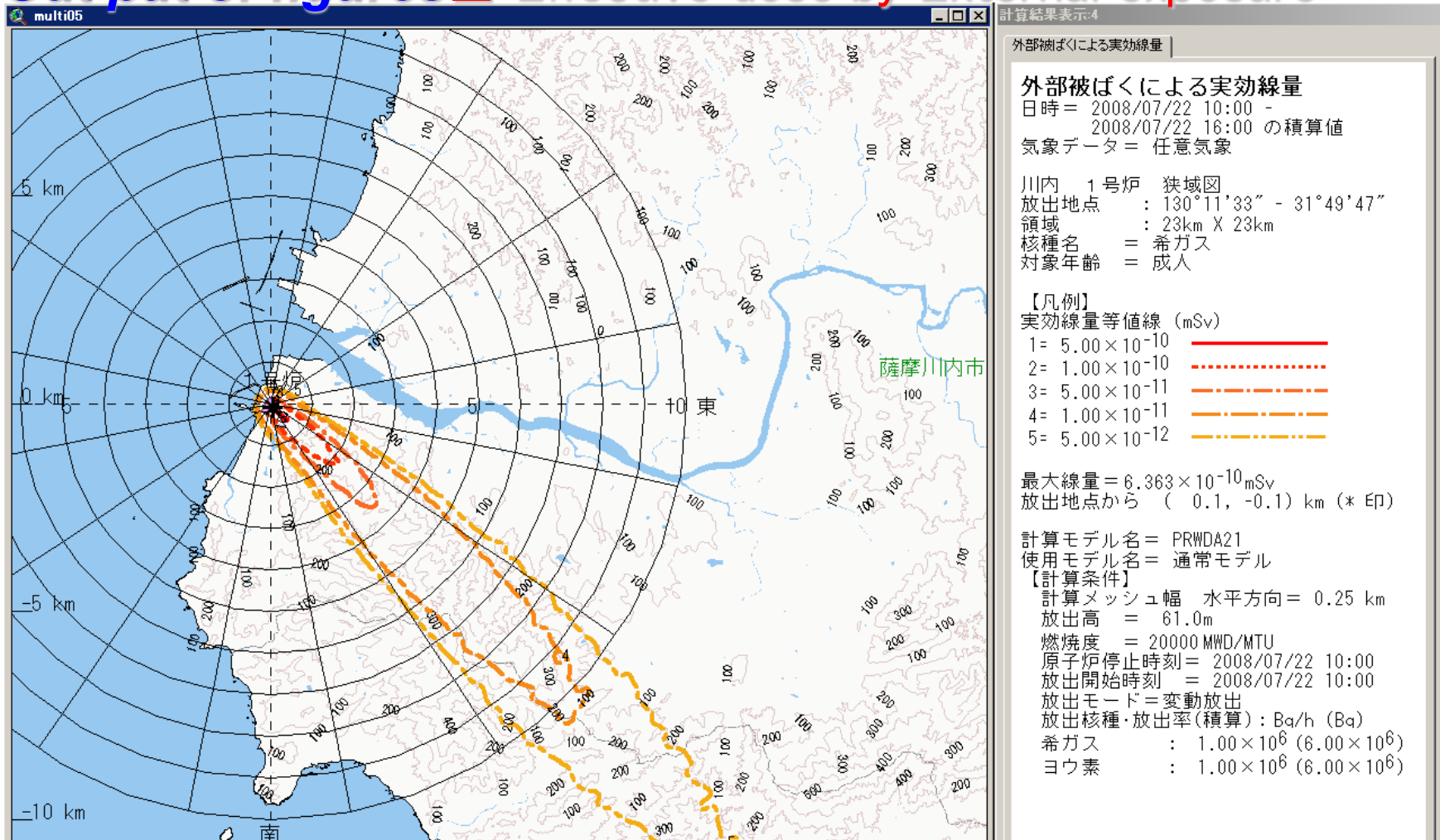


Surface deposition by radioactive plume(Bq/m²)

① Judgment of environmental sampling point

② Judgment of food and drinking water control by ①

Out put of figures ■ Effective dose by External exposure

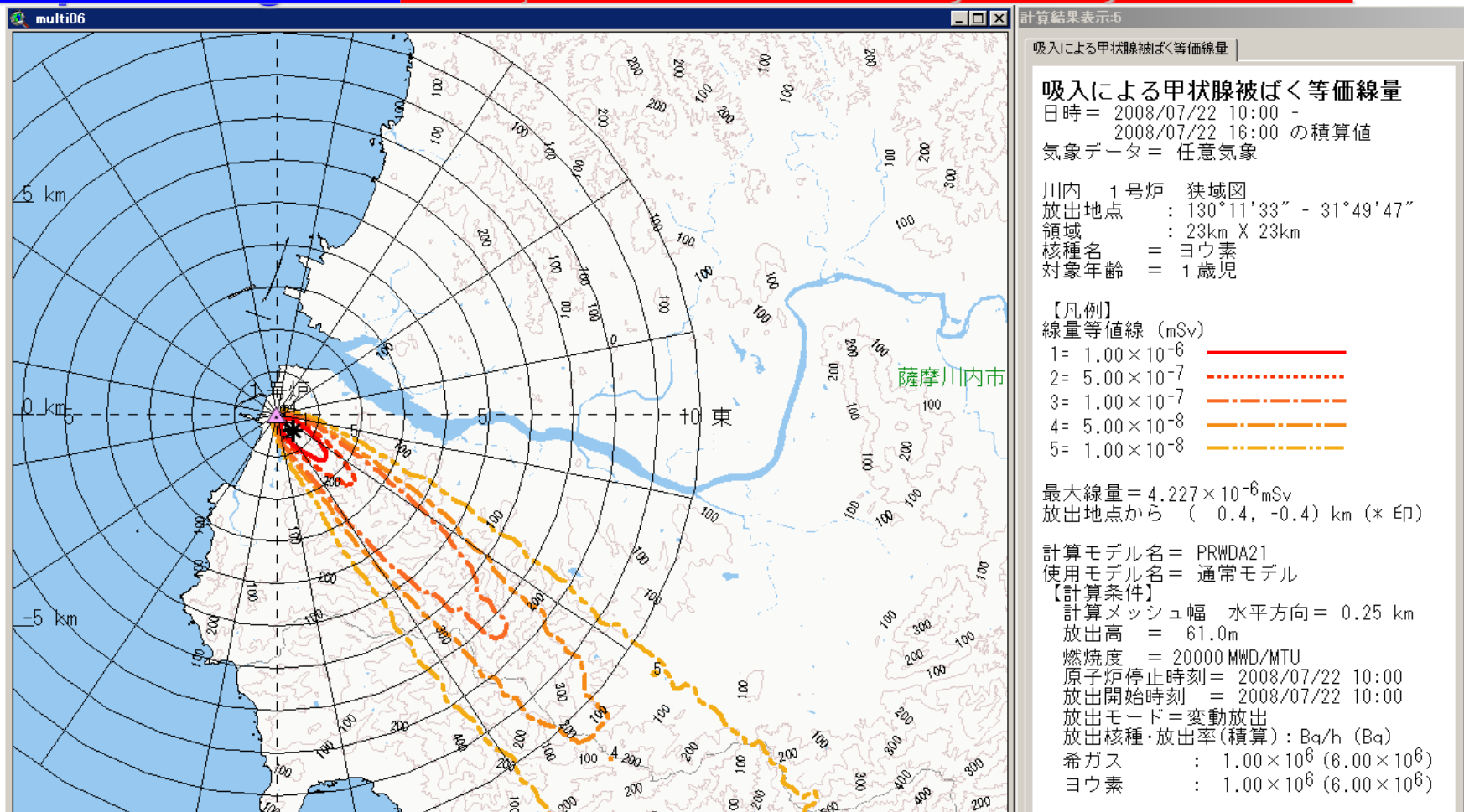


External exposure effective dose by radioactive plume and surface deposition(mSv)

① Estimation of inhabitants external dose

② Judgment of sheltering, evacuation and other protective measure

Output of figures ■ Equivalent dose of thyroid by inhalation



Thyroid equivalent dose by the inhalation of radiation plume including iodine Age dependent (mSv)

- ① Judgment of the application of stable iodine pill
- ② Estimation of inhabitants internal dose
- ③ Judgment of sheltering, evacuation and other protective measure

How to use a prediction system?

- ✓ Positioning of SPEEDI system in the emergency countermeasure

Desk top plan and practical strategy

Who operate, judge and order?

MEXT, NISA, NSC, Cabinet?

Prediction system

> incase of failure who can take a liability?

- ✓ Top management in emergency

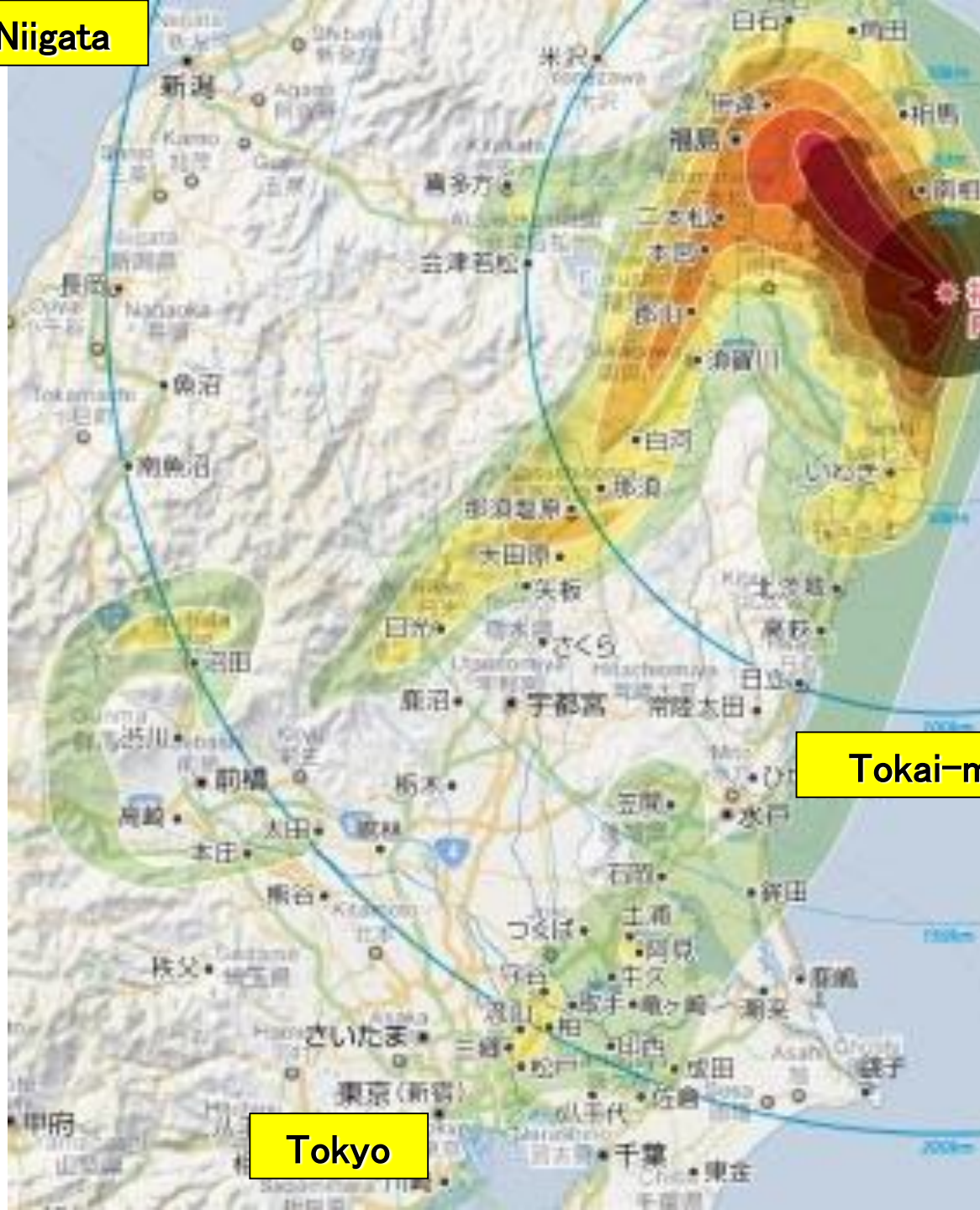
To show every thing always has a political risk!

How to keep a quality of topmanager.

- ✓ Positioning of science and technology

Separate specialization and Integrated judgment and order

Niigata



Fukushima

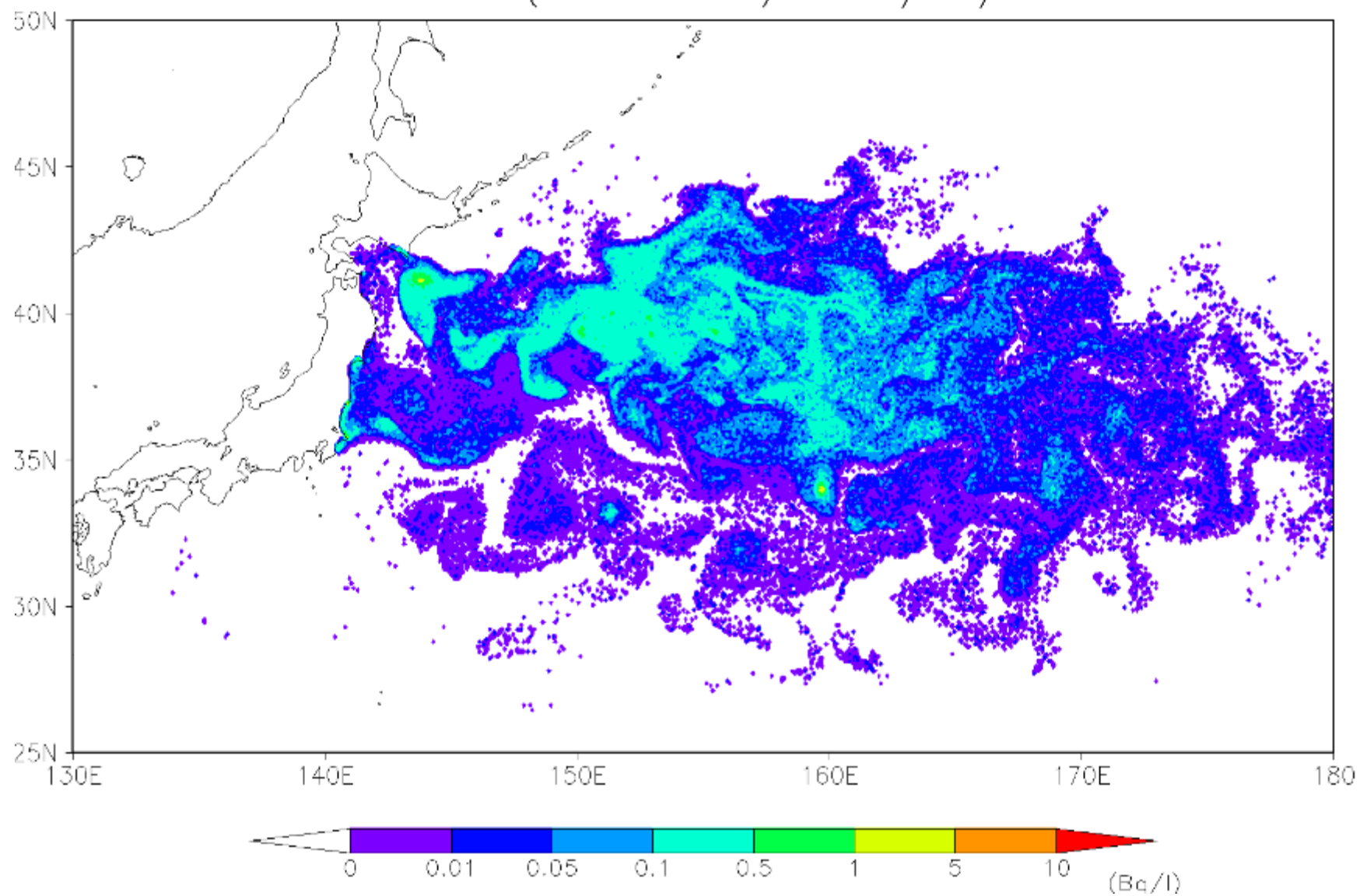
100km

Tokai-mura

Tokyo

200km

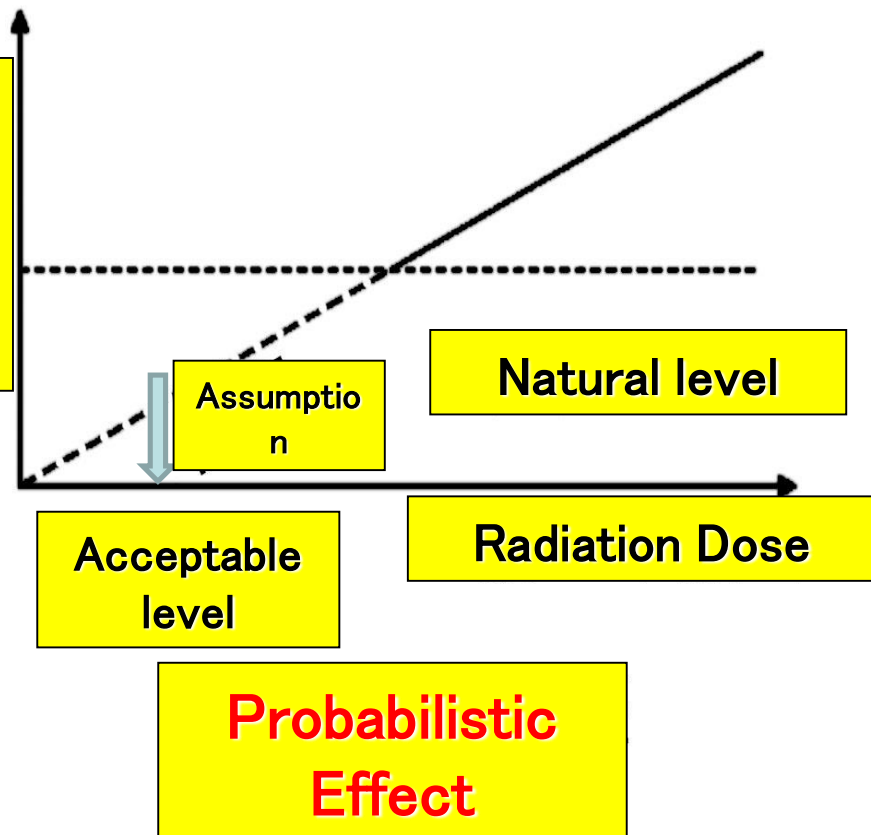
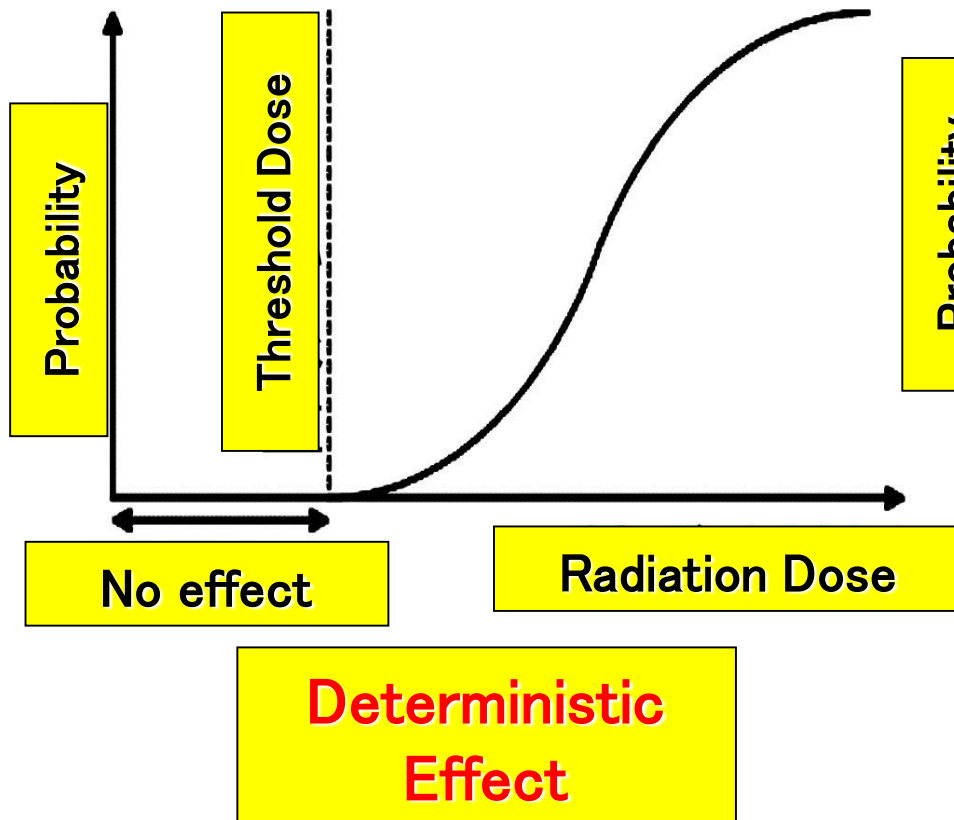
JCOPE2 (Cesium137) 2011/08/31



Radiation risk to human being

Development of
radiation risk understanding

- Specialist risk understanding
- Public risk understanding



Baby and children's problem

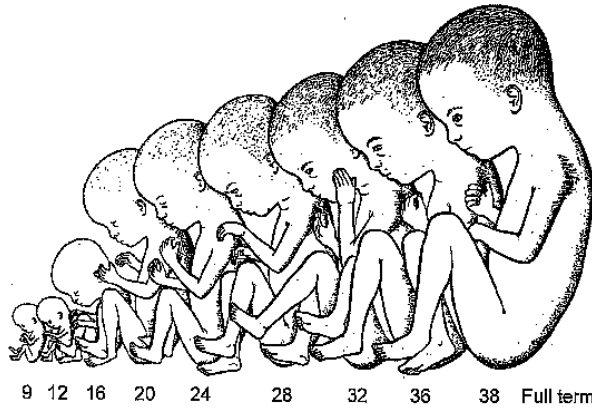


Fig. 3.2. The fetal period, extending from Week 9 to birth (Reprinted with permission from Moore et al., 1994 *Color Atlas of Clinical Embryology* ©W.B. Saunders Co., Philadelphia, PA.).

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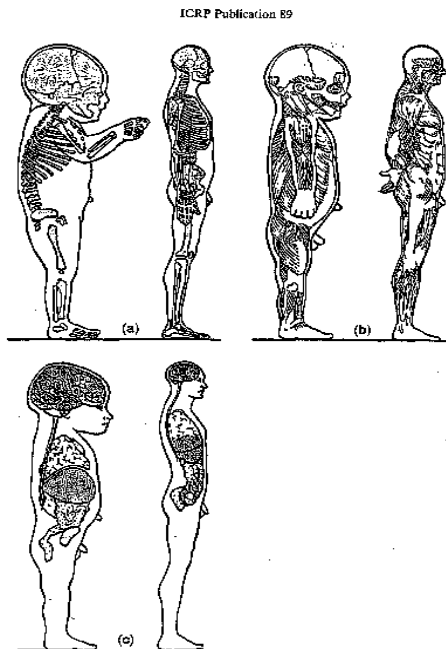


Fig. 4.9. Right lateral views of the newborn infant and adult male reconstructed to the same height (Seemmon, 1953). (a) The skeleton, (b) the musculature, subcutaneous tissue, and skin, and (c) the major visceral mass and the central nervous system.

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Dose Constraints and Reference Levels (ICRP)

Projected Dose (mSv)	Characteristics and Requirements	Type of Exposure Situation
20 - 100	Exceptional situations. Benefit on a case-by-case basis. Information, training and individual monitoring of workers, assessment of public doses.	Emergency Existing
1 - 20	Individual or societal benefit. Information, education and training. Individual monitoring or assessment.	Emergency Existing Planned
0.01 - 1	Societal benefit (not individual). No information, training or individual monitoring. Assessment of doses for compliance.	Planned

How to operate an existing exposure situations?

✓ Too high, too low policy!

Too high: Below 100mSv – Nothing will occur.

Too low: Below 1mSv – Too low and impossible, sometimes too much nerves.

✓ Optimization problem under existing situation.

The concept of averted dose is important for the trade off optimization in decision making procedure.

✓ For final decision the “stakeholder involvement” is inevitable in decision making procedure.

> This is a lesson from the Chernobyl reactor accident.

The composition of table-top guide level will be refused.

✓ Reference will be good by ICRP-82 and ICRO-111.



Food contamination

Other material contamination





Early stage clean- up (or decontamination)



Nuclear damage compensation system is tolerable?

- ✓The range of compensation

Radiation based on the zone, Farmers, Fisherman,
Physiological damage by evacuation (e.g. 60
thousand USD) etc.

- ✓Government assessment committee will decide each issue of compensation.

- ✓Utility liability (TEPCO)

1,200 Million USD per reactor site

In this stage: Under discussion

--10,000 Million USD is proposed by Banks.

- ✓Government support

In this stage: Under discussion

--10,000 Million USD is proposed.

International activities

- + Japan Health Physics Society (JHPS)
- + International Radiation Protection Association (IRPA)
- + Asian and Oceanic Association for Radiation Protection (AOARP)
- + Health Physics Society, US (HPS)

