

**Lessons Learned from Fukushima Nuclear Disaster  
and Restart of Nuclear Power Stations in Japan:  
Four years have passed  
since Great East Japan Earthquake in 2011.3.11.**

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炉型 Reactor	運転中 OP	建設中 UC	計画中 PL	閉鎖 CD
PWR	■	▨	□	⊗
BWR	■	▨	□	⊗
その他 Others	▲	▲	▲	⊗

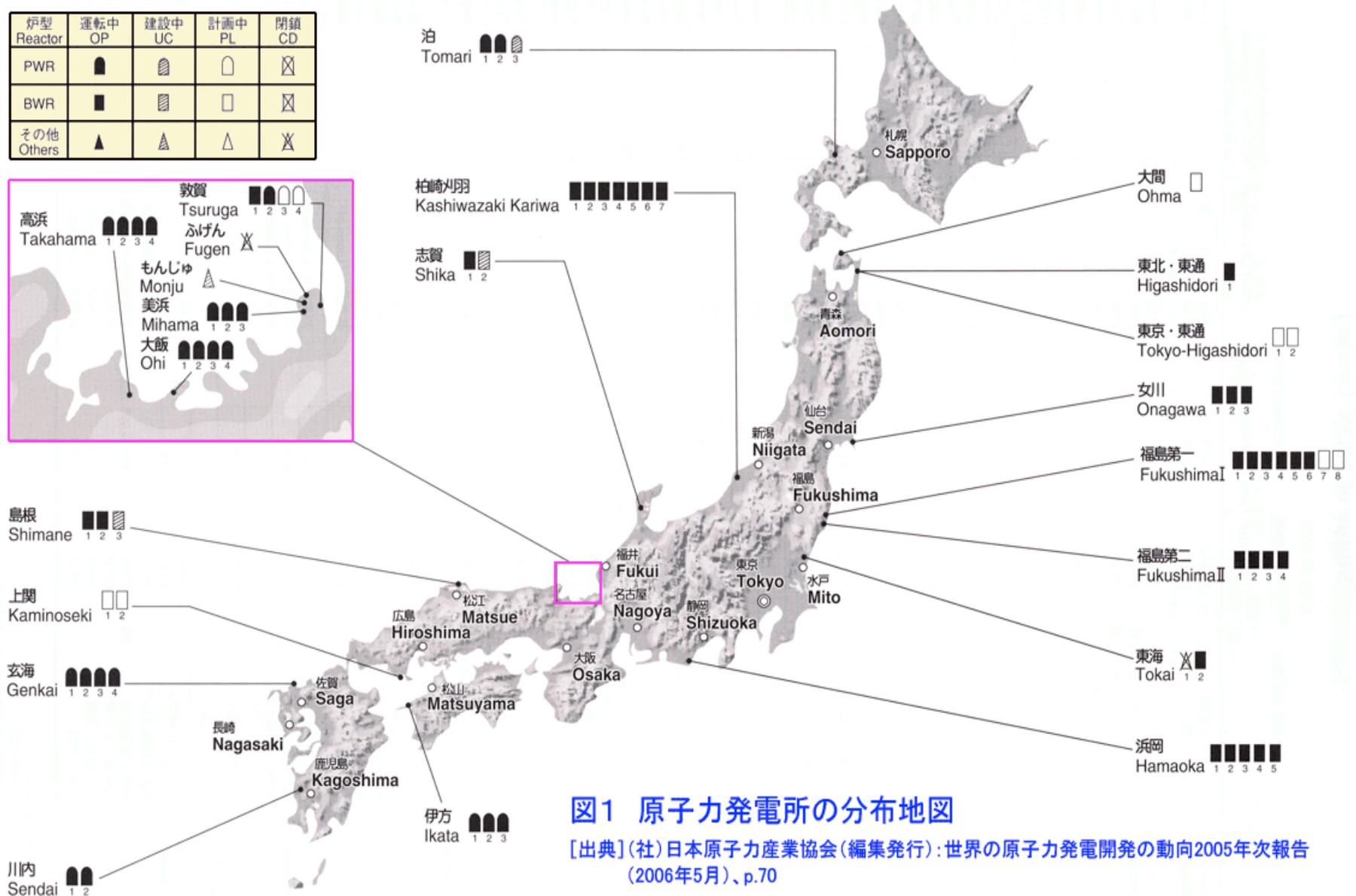
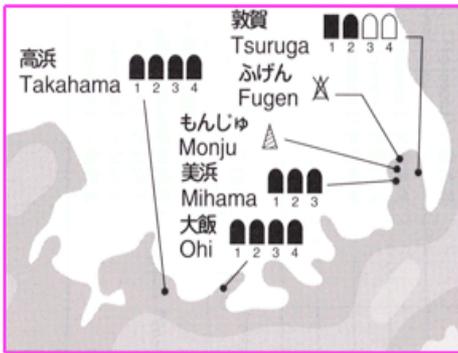
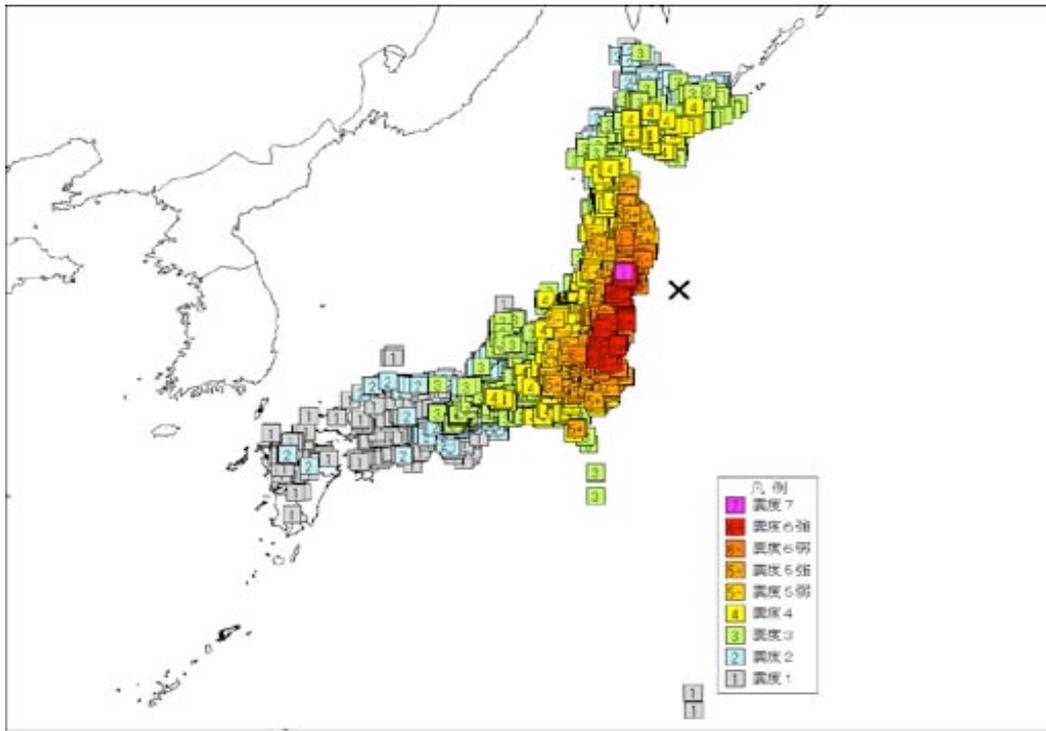


図1 原子力発電所の分布地図

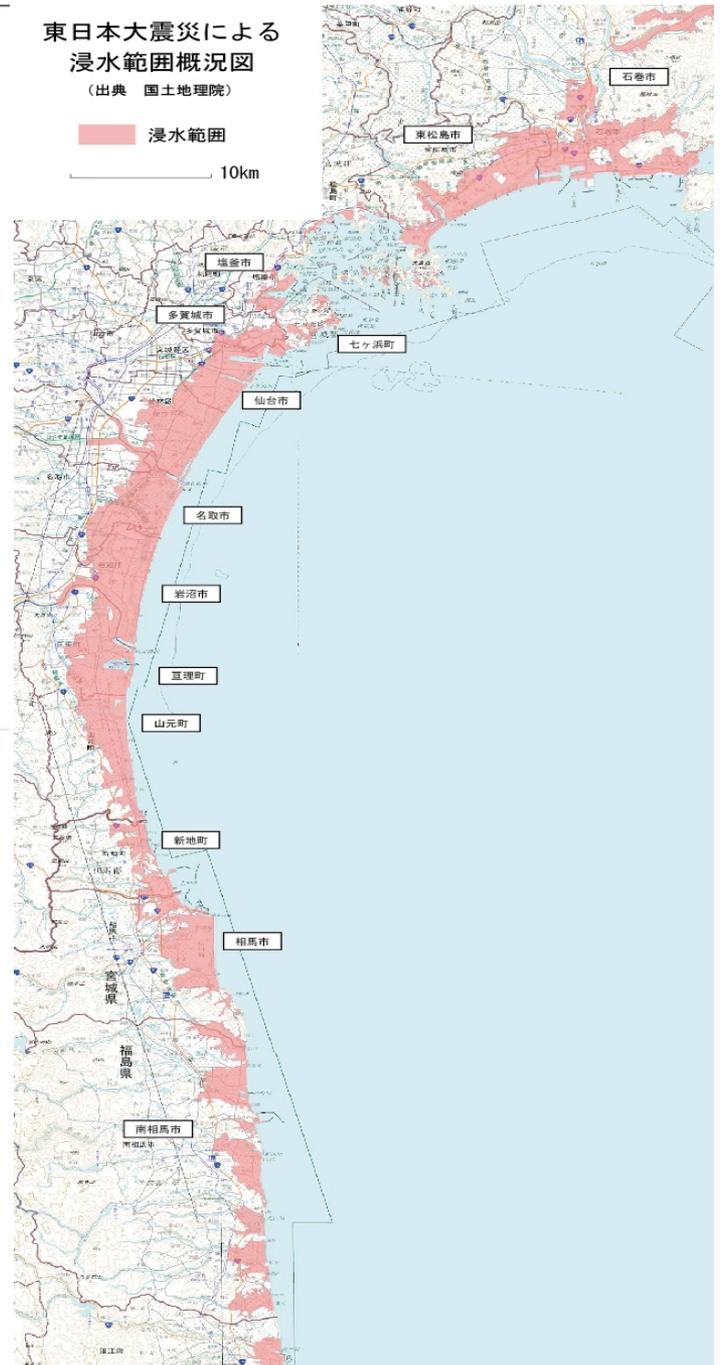
[出典] (社)日本原子力産業協会(編集発行):世界の原子力発電開発の動向2005年次報告(2006年5月)、p.70



### 東日本大震災による 浸水範囲概況図

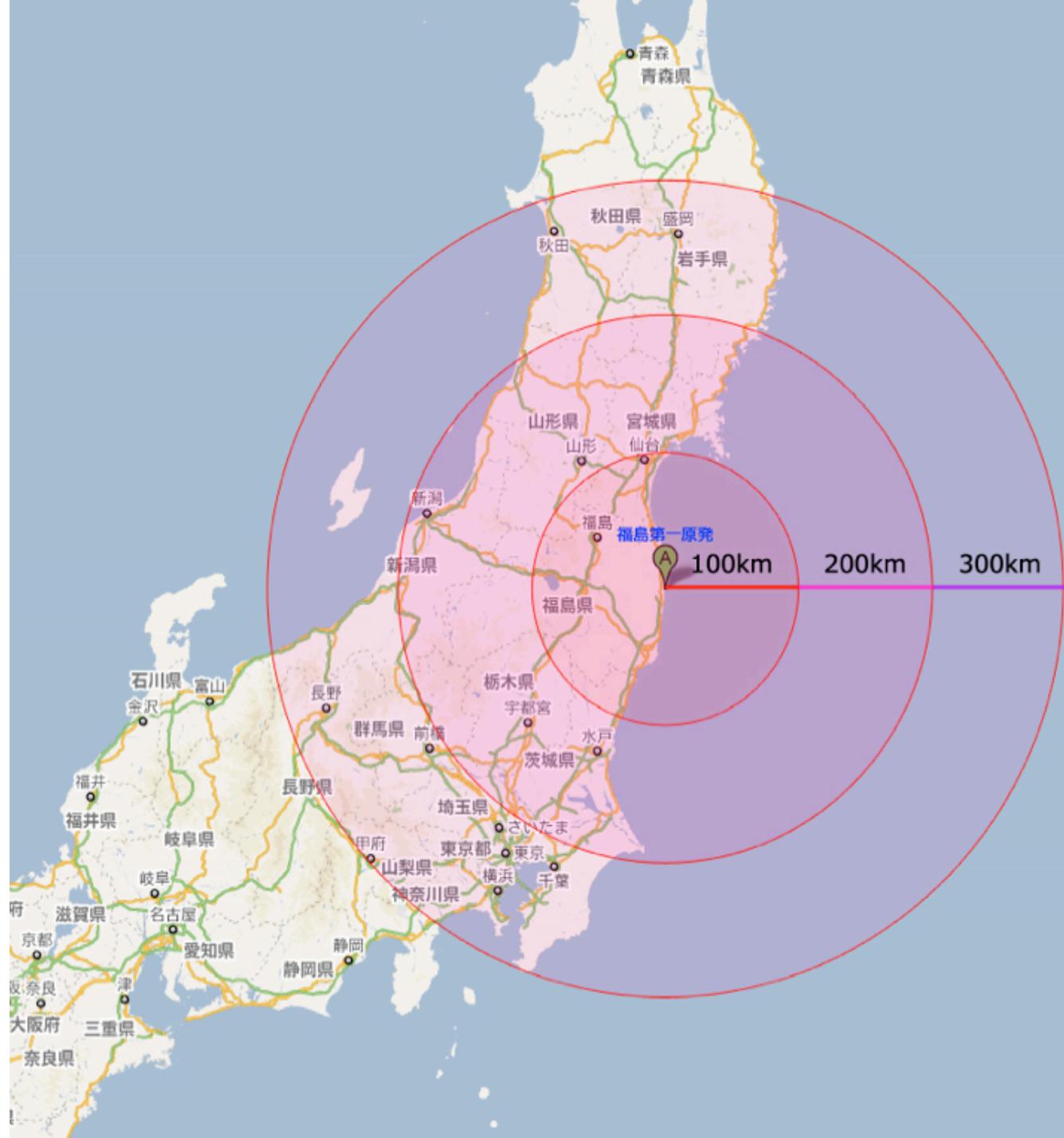
(出典 国土地理院)

浸水範囲  
10km



# Great East Japan Earthquake 2011.3.11







# 地震で外部電源喪失、津波で非常用DG停止→冷却源喪失

①地震発生→スクラム(核反応停止)

注記:

- 地震時に運転中の全てのユニットは自動的に停止された。
- 津波が襲う前までは、非常用ディーゼル発電機(D/G)は適切に作動していた。

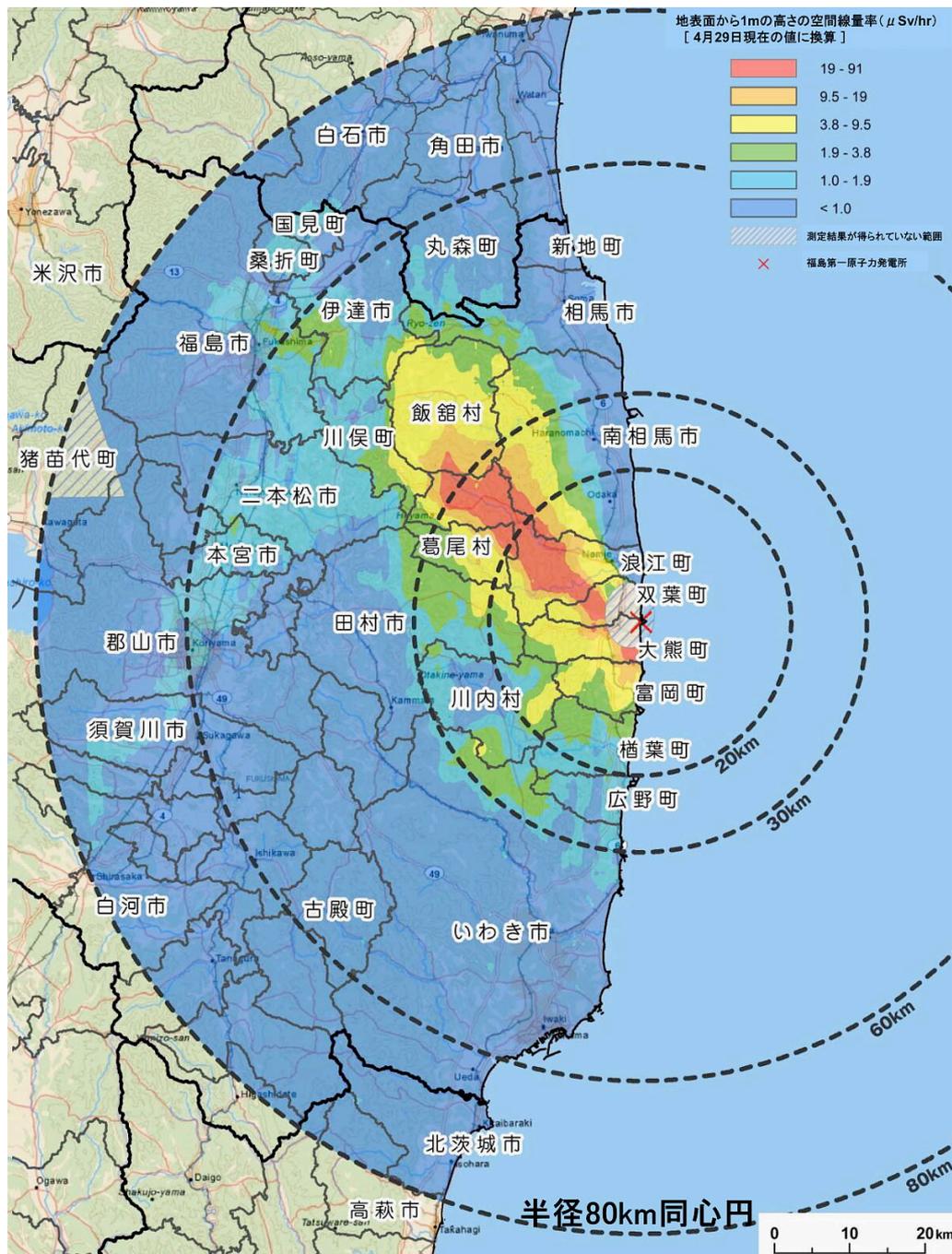
③非常用ディーゼル作動

②地震で外部電源喪失

津波(10m以上と推定)



④津波で非常用電源停止



文部科学省及び米国DOEによる航空機モニタリングの結果

2011.3.11

# Actions taken right after the earthquake

14:46

A 9.0 Magnitude Earthquake

15:27 ~  
Tsunami arriving

METI established an Emergency Response Headquarters for the disaster

NISA called up essential ERC personnel and formed six squads, each with a specific function.

NISA Director-General Terasaka was dispatched to the Crisis Management Center at the PM's Office.

15:42  
STATION BLACKOUT of the Fukushima Daiichi Nuclear Power Plant

15:42  
Based on Article 10, Clause 1 of the Act on Special Measures Concerning Nuclear Emergency Preparedness notified by TEPCO.

NISA informed the PM's Office and other competent bodies.

METI established a NEPHQ in ERC and a Local NEPHQ in the Off-site Center

16:36  
Disability of the emergency core cooling system of Units 1 and 2.

16:42  
Based on Article 15, Clause 1 of the Act notified by TEPCO.

NISA informed the PM's Office and other competent bodies.

16:36  
Crisis Management Deputy Chief Ito established an Emergency Response Office in the PM's Office.

Around 17:00  
Several TEPCO executives were summoned to the PM's Office as requested to explain the situation

Around 17:35  
METI Minister Kaieda agreed to declare a nuclear emergency situation.

Around 17:42  
METI Minister Kaieda and NISA Director-General Terasaka submitted the Article 15 Situation to PM and asked him to agree to declare a nuclear emergency situation. The report was suspended at 18:12 for PM's schedules.

PM's Office took time before launching the emergency action.

18:10  
Start of reactor core exposure

18:50  
Start of reactor core damaged

19:03 – 19:22  
the first NERHQ meeting was held in the Prime Minister's Office

19:03  
A declaration of a nuclear emergency situation was issued by the government.

NERHQ at the PM's Office, a Local ERHQ at Off-site Center, and the NERHQ secretariat in the Emergency Response Center (ERC) were established.

✗ lack of information sharing

around 20:00~  
PM gathered members in a small room on the mezzanine floor and formed a team for the accident response.

Fukushima Prefectural Government had a sense of crisis

around 20:00~  
PM gathered members in a small room **on the mezzanine floor** and formed a team for the accident response.

Around at 21:00 to 22:00  
NISA Vice Director-General Hiraoka, NSC Chair Madarame, and TEPCO Fellow Takekuro also joined to provide explanations.

Proposal of a venting operation by NSC Chair Madarame

It consisted of the Prime Minister Kan, Chief Cabinet Secretary Edano, METI Minister Kaieda, Deputy Chief Cabinet Secretary Tetsuro Fukuyama, Special Advisor Hosono, and NISA Director-General Terasaka

Fukushima Prefectural Government was feeling sense of crisis

20:50 ... 1st EI  
Fukushima Governor ordered evacuation of Futaba Town and Okuma Town **within a radius of 2km from the plant.**

21:23 ... 2nd EI  
An evacuation instruction was issued by PM to **persons within a radius of 3 km from the plant.**

**× confusion in decision-making and communication gap**

**2011.3.12**

0:06  
Site Superintendent Yoshida ordered preparations for the venting of Unit 1.

1:30  
Permission of a venting operation to TEPCO

3:05  
The press conference held by METI to announce a venting operation. It would be carried out at around 3:30

3:00 ~ 4:00  
no information on the progress in the venting to PM's office from NISA

3:30  
The venting was not carried out on time. Trial-and-error efforts were exerted manually in carrying out the venting, due to loss of power of the valves that operated by air pressure

**× information did not reach where decisions should have taken**

The PM's Office was irritated, as a venting operation was delayed

Around at 5:00  
PM asked and TEPCO Fellow Takekuro why the venting was not being carried out.

The answer was "I don't know."

5:44 ... 3rd EI  
The evacuation zone was determined to be expanded **within a 10km radius**

around 6:00  
MELTDOWN of Unit 1

In the helicopter, PM asked NSC Chairman Madarame about the possibility of hydrogen explosion.

Madarame answered "It wouldn't happen."

6:15  
PM departed for the plant, together with NSC Chairman Madarame.

7:12  
PM arrived at the Fukushima Daiich NPP by helicopter, for an inspection and a demand of implementation of venting.

6:50  
METI Minister Kaieda ordered TEPCO to carry out the venting based on Reactor Regulation Act

7:45  
Issuance of the declaration of a Nuclear Emergency Situation of the Fukushima Daini NPP

8:37  
TEPCO informed the Fukushima prefectural government about carrying out the venting around at 9:00. They were requested to undertake a venting when the evacuation of residents is completed.

9:02  
TEPCO instructed a venting operation, regarding the evacuation completed.

(The evacuation was actually not done at that time.)

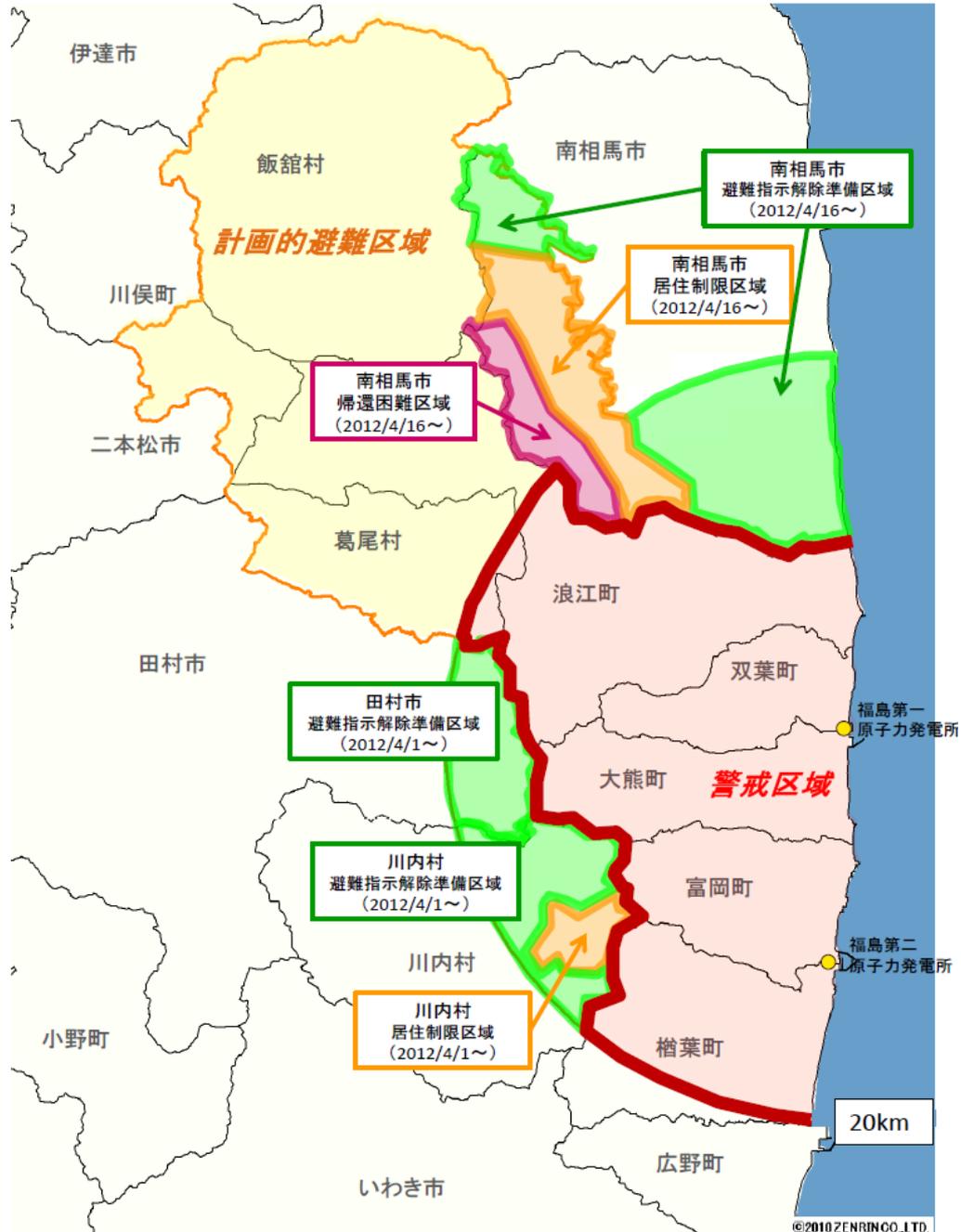
14:50  
A vent operation of Unit 1 was finally succeed.

15:36  
an explosion in the Reactor Building of Unit 1

**But it did happen. This contributed to the sense of mistrust.**

18:25 ... 4th EI  
The evacuation zone was be determined to be expanded within a 20km radius.

警戒区域と避難指示区域の概念図  
(平成24年4月1日以降)





【表1】福島県民の避難の状況

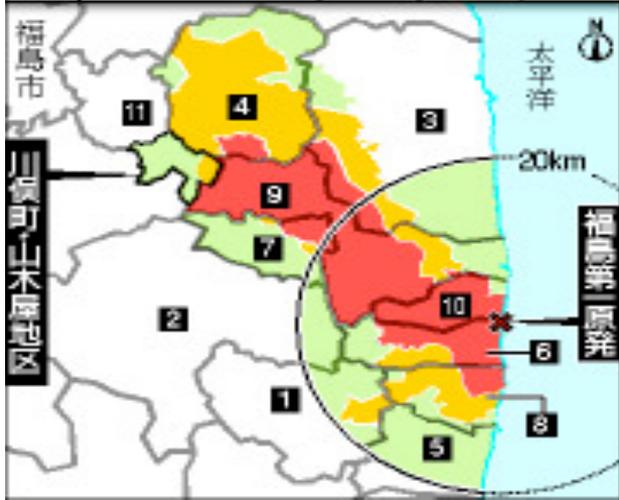
<b>避難者総数</b>		<b>159, 124人</b>	
県内避難者数	<b>96, 857人</b> (H24.1.23 現在)		
	・仮設住宅入居者数	31,696人	
	・借上住宅入居者数	63,731人	
	・公営住宅入居者数	1,428人	
	・その他(二次避難所)	2人	
県外避難者数	<b>62, 267人</b> (H24.1.12 現在)		
	・山形県	12,960人	
	・東京都	7,479人	
	・新潟県	6,715人	
	・埼玉県	4,611人	ほか

※ 出典：福島県調べ（原子力災害以外の避難も含む）

避難指示区域の再編状況

自治体 (再編実施日)	区域 再編困難	区域 居住制限	除避難 指示区域
1 川内村 (2012年4月1日)	—	60人	300人
2 田村市 (12年4月1日)	—	—	380
3 南相馬市 (12年4月16日)	2人	510	12740
4 飯沼村 (12年7月17日)	280	5260	800
5 楢葉町 (12年8月10日)	—	—	7600
6 大熊町 (12年12月10日)	10560	370	20
7 葛尾村 (13年3月22日)	120	70	1320
8 富岡町 (13年3月25日)	4650	9800	1470
9 浪江町 (13年4月1日)	3400	8420	8050
10 双葉町 (13年5月28日)	6270	—	250
11 川俣町 (13年8月8日)	—	130	1070
計	2万5282	2万4620	3万4000

政府の原子力被災者生活支援チームがまとめた  
再編実施時点の避難者の概数







# Diversified Sufferers (Victims) of Great East Japan Earthquake and Fukushima Nuclear Accident

Damage by Great Earthquake and Tsunami

Evacuation (evacuee, displaced people and refugee) from Fukushima Nuclear Accident

1. Compulsory Evacuation (90,000 → 70,000)
2. Voluntary Evacuation (70,000 → 40,000)

as of May, 2015

Fukushima Pref.: 67,000 Out of Fukushima: 45,000

Compensation of Accident

1. Compulsory: ¥100,000/m + Property(house +land) + Wage loss  
Average Family (4 persons): ¥ 90Million ++
2. Voluntary: One-shot ¥120,000

(Children and Pregnant Women:¥520,000 )

# Fukushima Reconstruction Policy

Fukushima Critical Issue: Low Radioactive Pollution 100mSv/year

Post Accident Management: Fukushima Recovery

## 1. ICRP Criteria of Risk Management

(1) Emergency period: 100mSv ~ 20mSv

(2) Recovery period: 20mSv ~ 1mSv

(3) Normal period: 1mSv

## 2. Fukushima Risk Management: 20mSv ← Top Down process

Difficulty: >50mSv, Restriction: 50~20, Preparation: 20>

## 3. Early Returning Home, Decontamination from radioactive contamination and Compensation: Tri-dilemma

Decontamination Budget: 2.5 trillion yen

Low Radioactive Waste 5.05 million m<sup>3</sup>, Budget: 1.4 trillion yen

Compensation Budget: 4.7 trillion yen

# 放射線リスクに関する 基礎的情報



内閣府  
消費者庁  
復興庁  
外務省  
文部科学省  
厚生労働省  
農林水産省  
経済産業省  
環境省  
原子力規制庁

■我が国における対応■

## 15. 今回の原子力災害に対する我が国の対応 (避難指示、解除)

- 政府は、東京電力福島第一原発事故において、国際放射線防護委員会(ICRP)の緊急時被ばく状況における放射線防護の「参考レベル」<sup>(※1)</sup>のバンド(年間20~100ミリシーベルト)等を考慮し、このうち最も厳しい値に相当する年間20ミリシーベルトを採用して、避難指示を行いました<sup>(※2)</sup>。

$$\text{年間20ミリシーベルト} = \text{1日の被ばく線量} \times 365\text{日}$$

$$\begin{aligned} &\text{屋内での被ばく線量} \left[ 3.8\text{マイクロシーベルト} \times 16\text{時間} \times 0.4 \text{ (低減効果)} \right] \\ &+ \\ &\text{屋外での被ばく線量} \left[ 3.8\text{マイクロシーベルト} \times 8\text{時間} \right] \end{aligned}$$

※ 木造家屋の低減効果0.4は、IAEAがまとめた「Planning For Off-Site Response to Radiation Accidents in Nuclear Facilities(IAEA TECDOC=225)」によるもの。

※ 上記計算式では、①内部被ばく、②放射性物質の物理減衰やウェザリング効果を考慮していない。これは、①による線量増加分と②による線量減少分が相殺されると仮定しているため。



# What are the lessons from Fukushima?

Lessons from 「2011.3.11」, Great East Japan Earthquake, and Fukushima Nuclear Disaster

→Sustainability and Resilience

→Risk Management and Risk Governance

Risk Perception and Risk Communication:

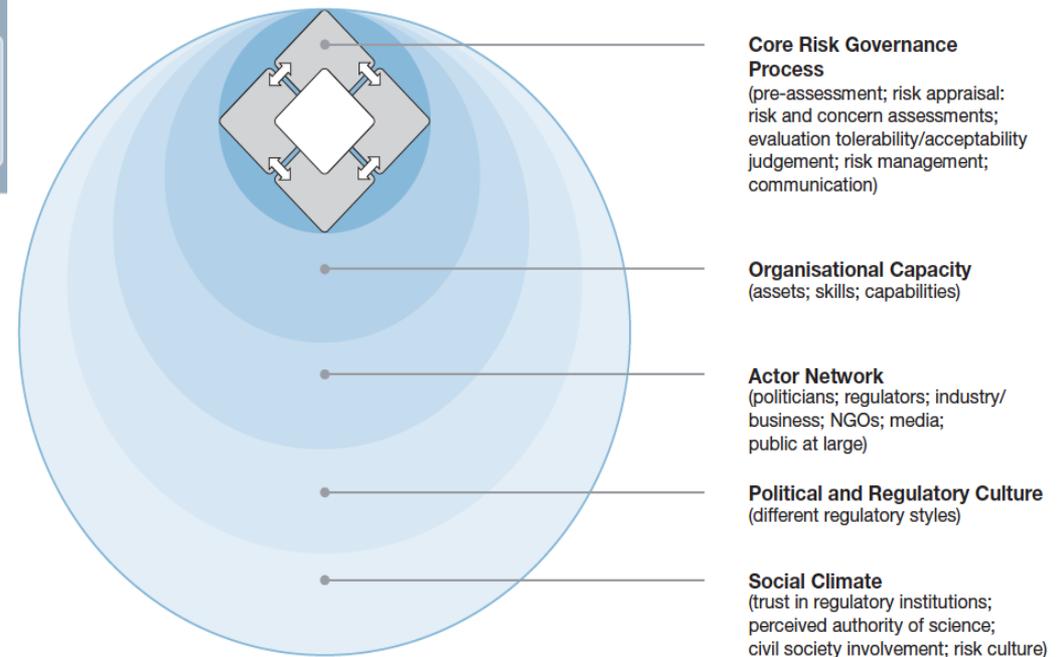
Low Radioactive Pollution 100mSv/year

Risk Characteristics and Risk Governance

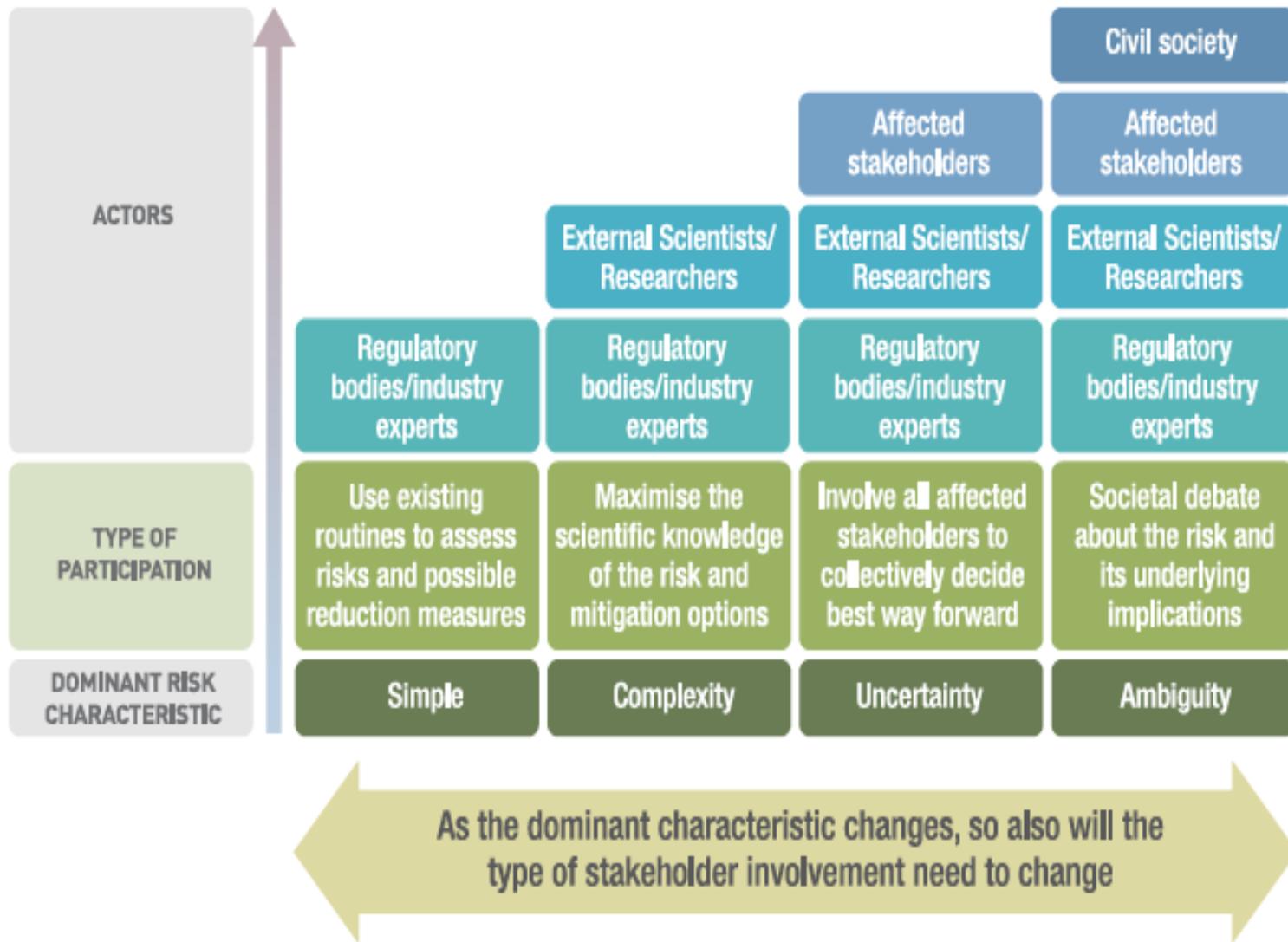
1. Simple
2. Complexity
3. Uncertainty
4. Ambiguity

Life Cycle Assessment of Nuclear Policy:

Nuclear Power Plant + Nuclear Fuel Recycle + Final Disposal



Source: IRGC(2008), *An Introduction to the IRGC Risk Governance Framework*, p.8 & 20.



Source: IRGC(2008), *An Introduction to the IRGC Risk Governance Framework*, p. 18.

