What can we learn from the 3.11 disaster ?

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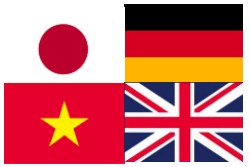
(Junior Associate Professor)

Outline

- Self-introduction
- 3.11 Earthquake – its damage and the reconstruction.
- Lessons and challenges from the 3.11 disaster.
- Two social impacts affected on energy policy in Japan
- Hydrogen energy activities in Japan

Self-introduction

Languages: 

Helmut Takahiro Uchida

1980 Born in Stuttgart (Germany)

1983 Moved to Tokyo (Japan)

2000-2006 Eng. Department at **Tohoku University**
(Sendai City, Miyagi Pref. Japan) (Bachelor + Master)

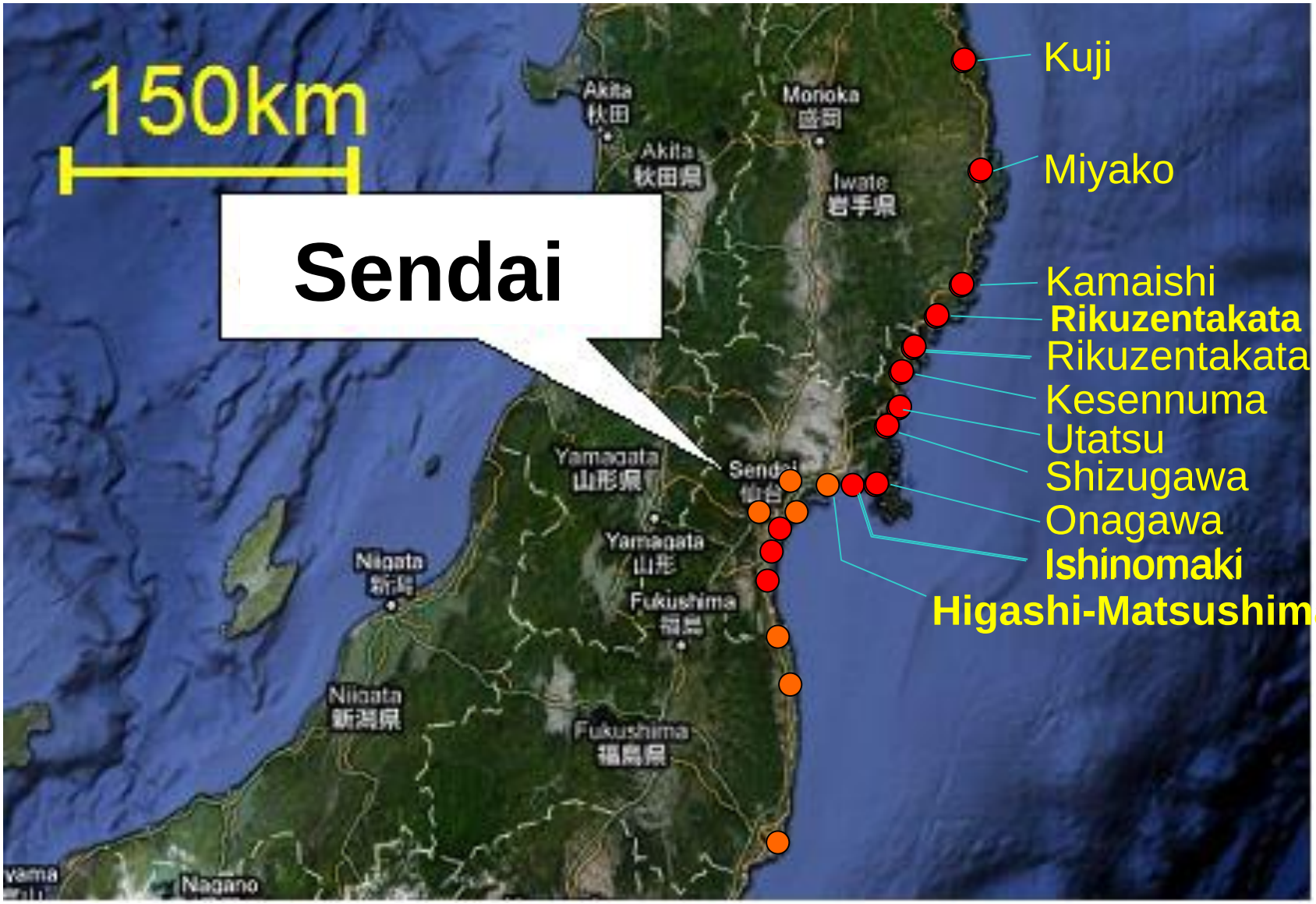
2006-2015 Department of Physics (Institut of material physics),
University Göttingen (PhD)

2016-2017 Department of Physics at **Tokai Univ.**(Kanagawa Pref.)

Apr.2017- Department of Precision Engineering at **Tokai Univ.**

Major: Material science (hydrogen functional materials, sensor materials)

Self-introduction



2004-2006 Support of Smatra-Tsunami disaster @Tohoku

2011- Support of Tohoku-Tsunami disaster @Göttingen

Japanese earthquake intensity scale

“Acceleration”

Magnitude

“Energy”

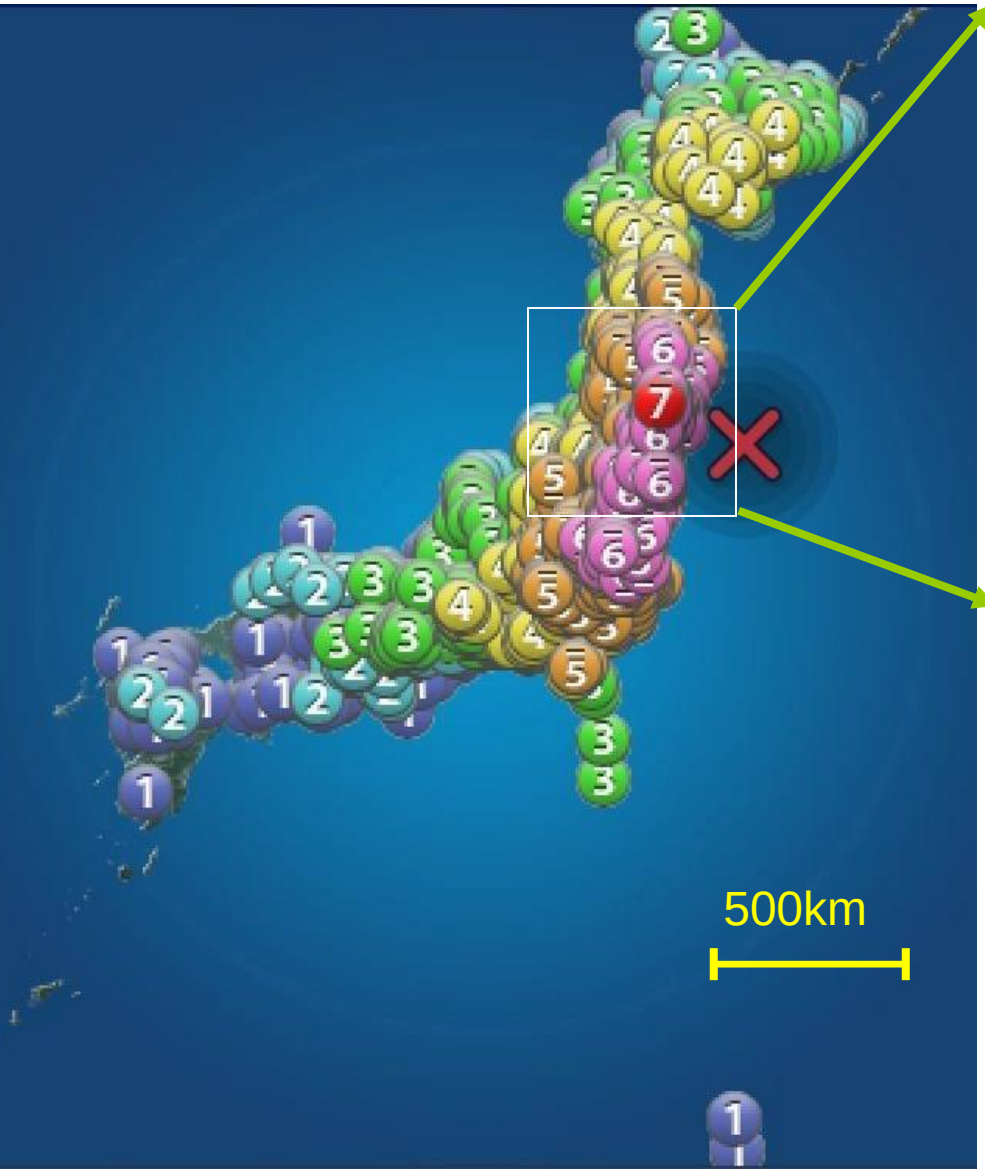
JMA(Japan Meteorological Agency) Category

1
2 (“Most people can feel the shaking”)
3
4
5- (“Shaking may cause difficulty in walking”)
5+
6- (“Difficult to stand upright”)
6+
7 (“Thrown by the shaking and impossible to move at will. Most furniture moves to a large extent and jumps up.”)

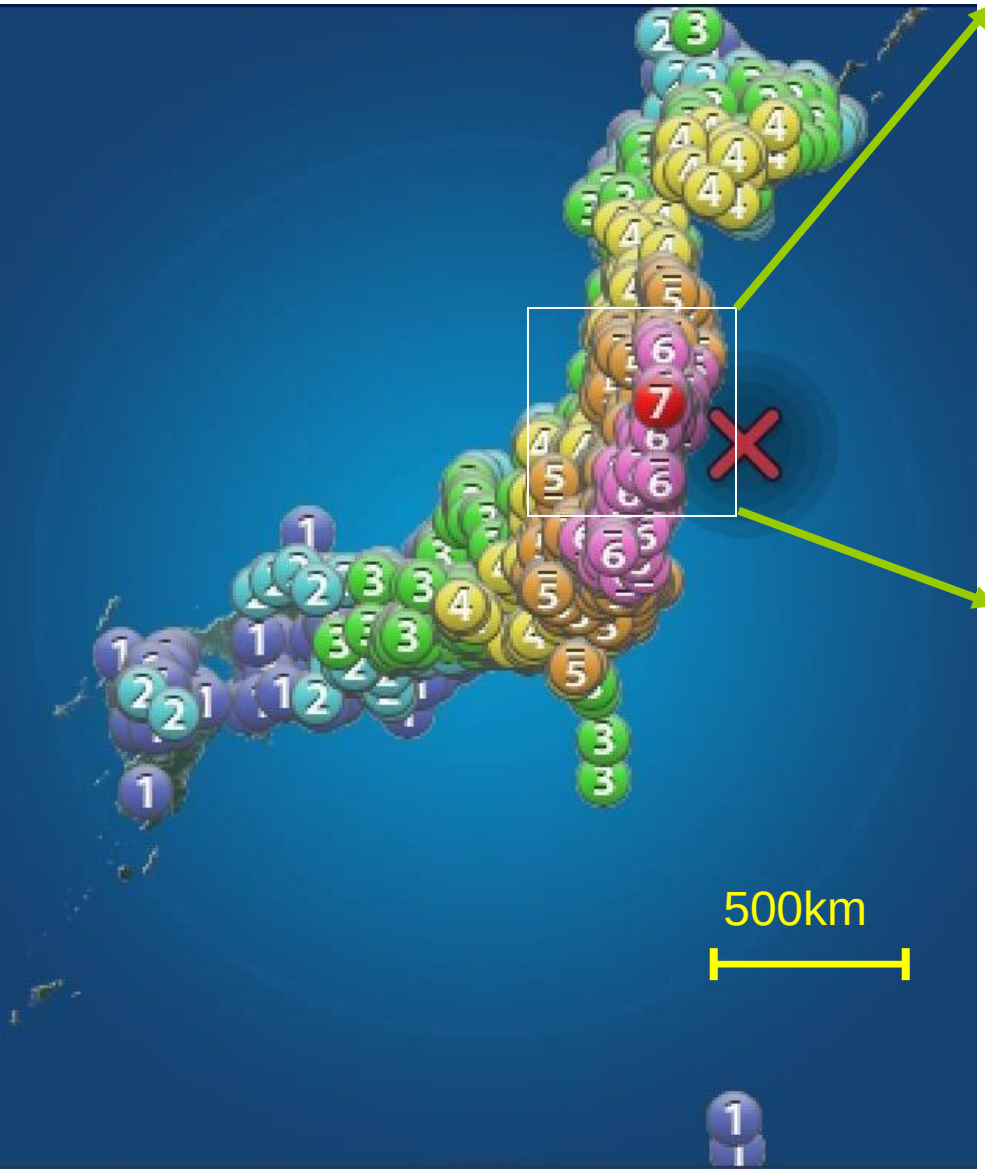
(Further Information available at https://en.wikipedia.org/wiki/Japan_Meteorological_Agency_seismic_intensity_scale

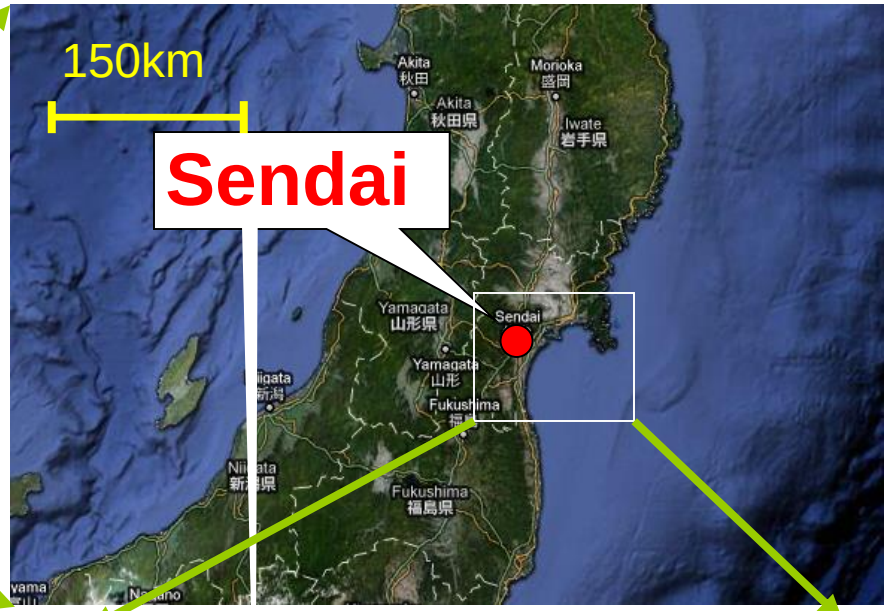
Main Earthquake(11.Mar.2011, at 14:46)

Main Earthquake(11.Mar.2011, at 14:46)

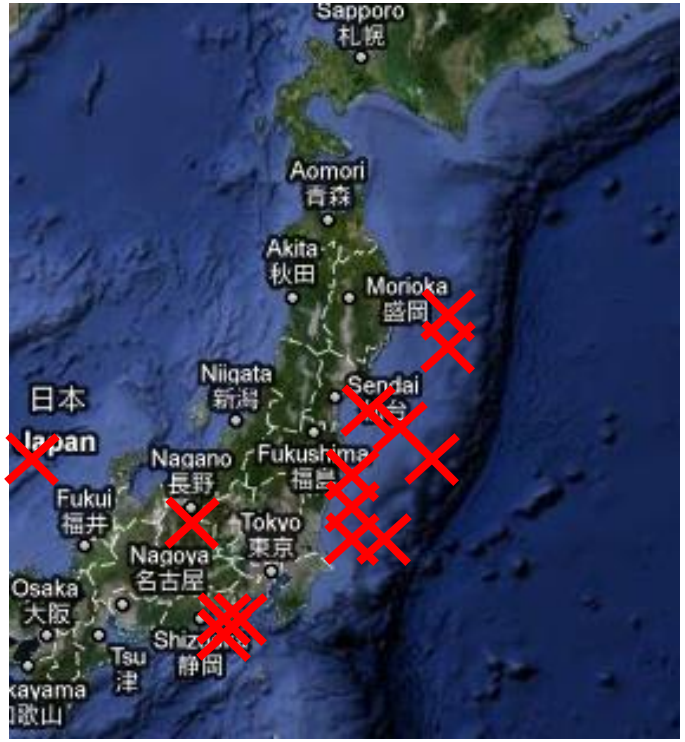


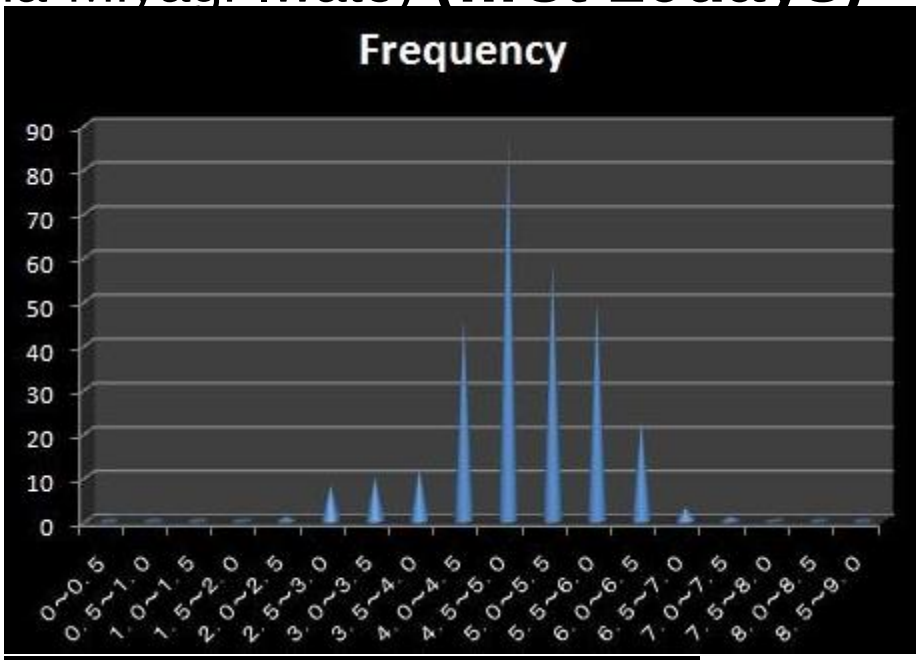
Main Earthquake(11.Mar.2011, at 14:46)

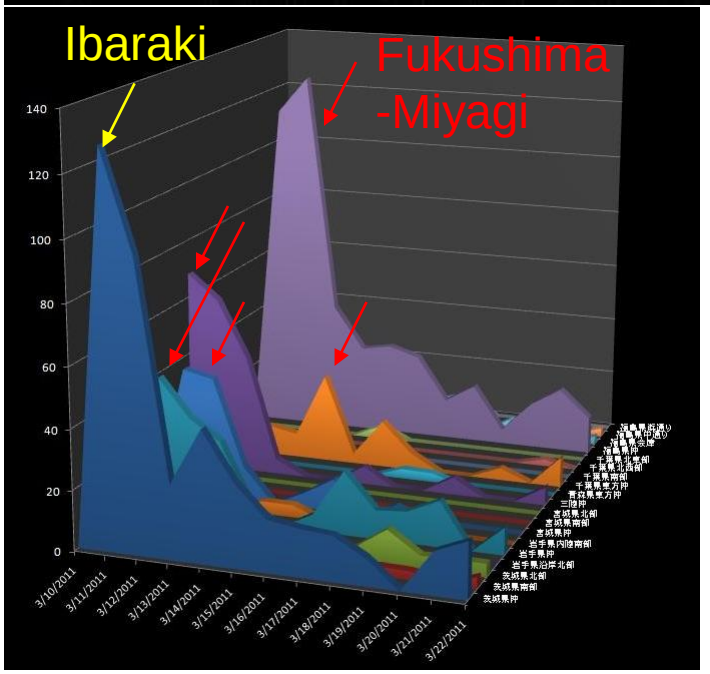




Aftershocks (Ibaraki-Fukushima-Miyagi-Iwate) (first 10days)





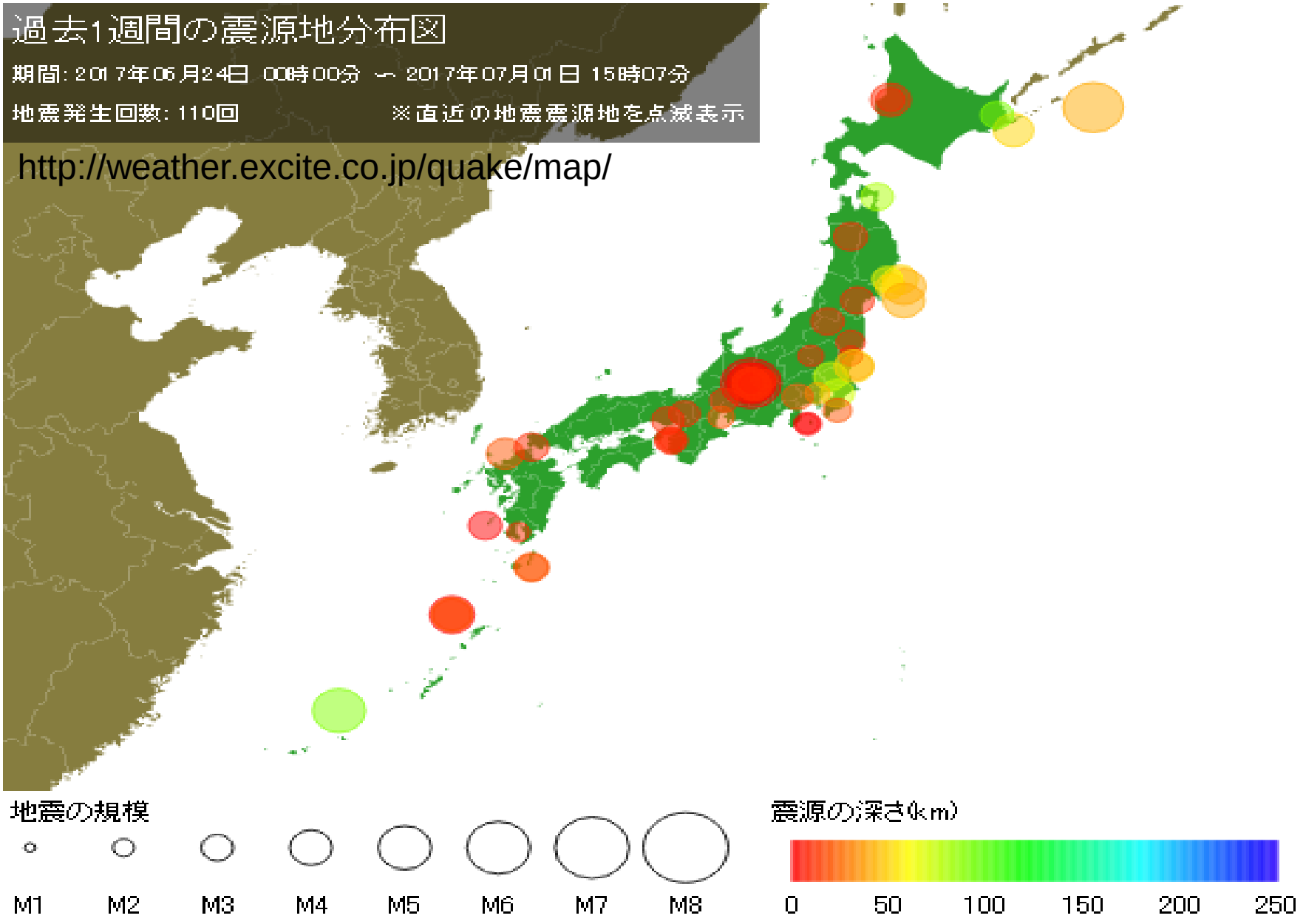


Aftershock (>M5.0)
355 times (by 22.Mar.2011)

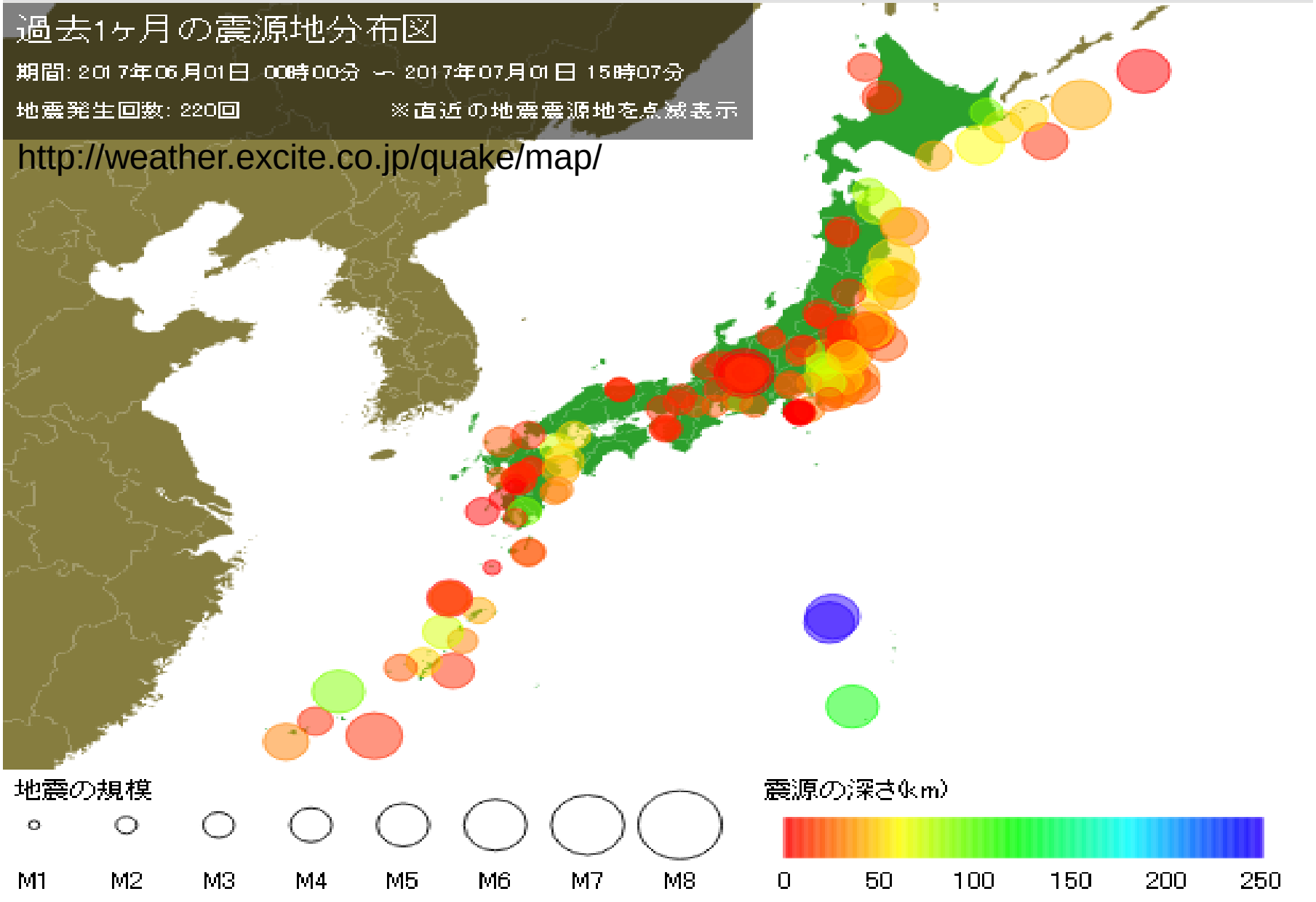
More than 1 times / hour in Sendai-area

(Data from JMA)

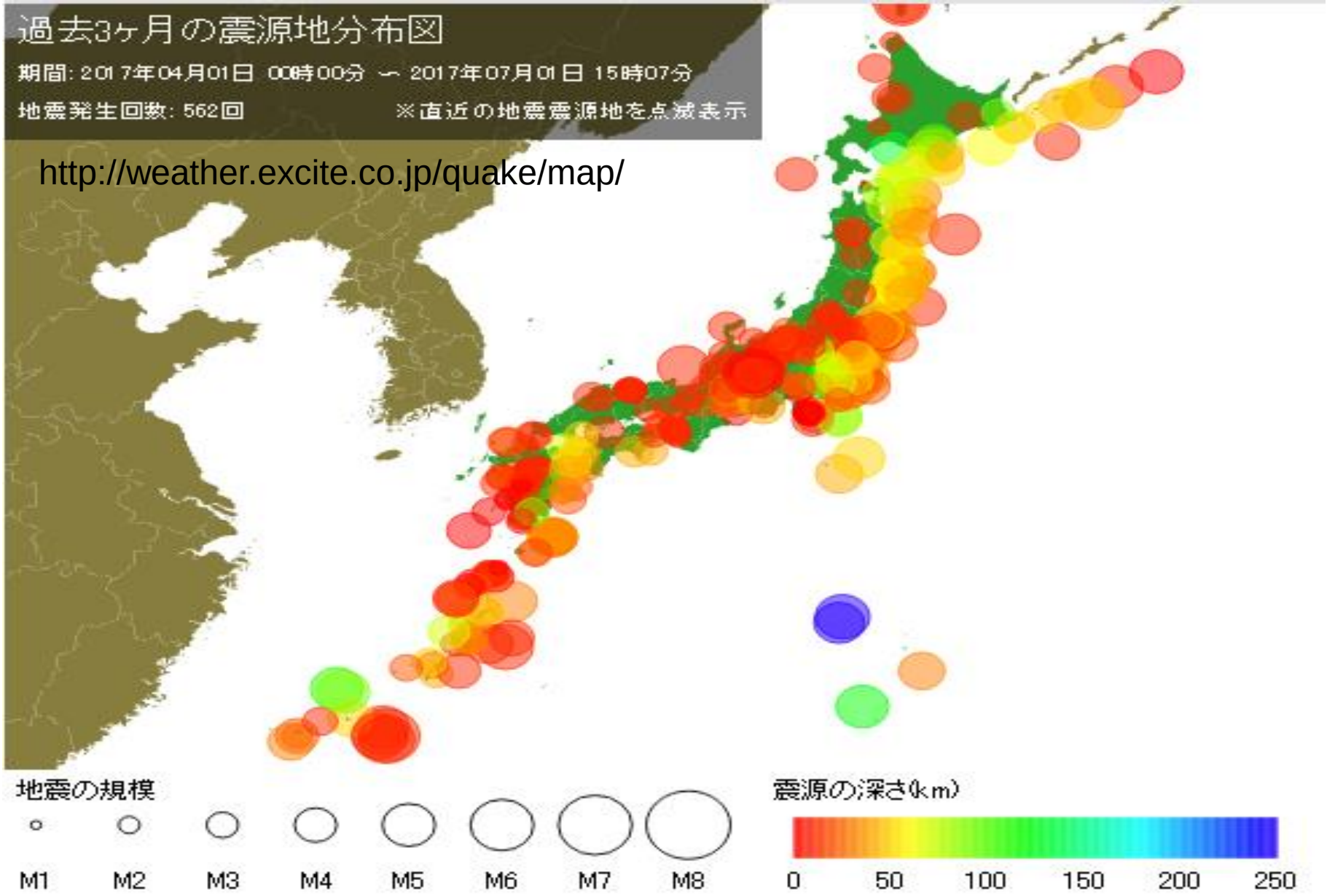
Frequency of Earthquake in Japan < 1 week 24 Jun.– 01. Jul. 2017



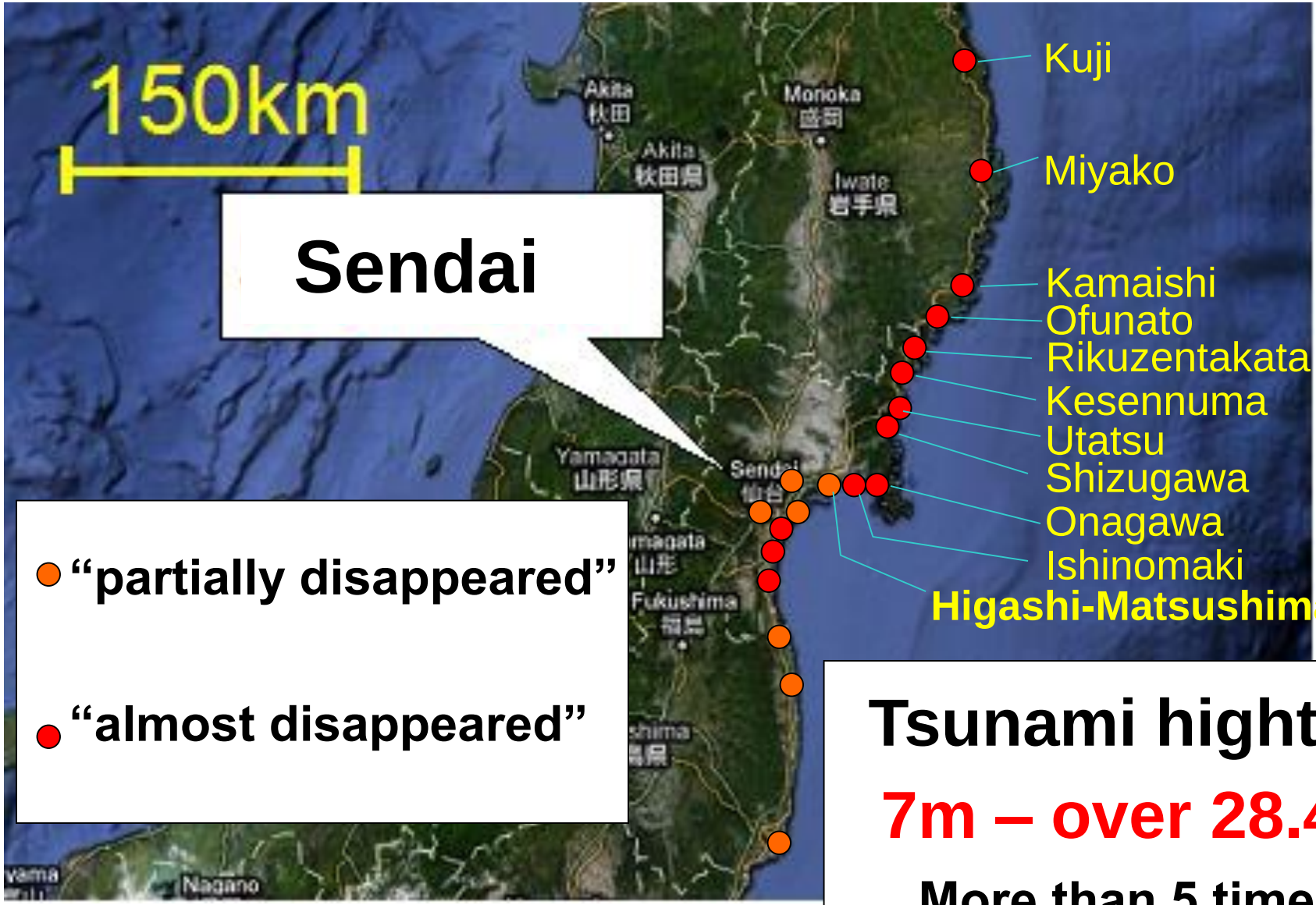
Frequency of Earthquake in Japan < 1 month 01 Jun. -01 Jul. 201



Frequency of Earthquake in Japan < 3 months 01 Apr.-01 Jul. 2017



Tsunami (first wave:10-20min. After the main earthquake)



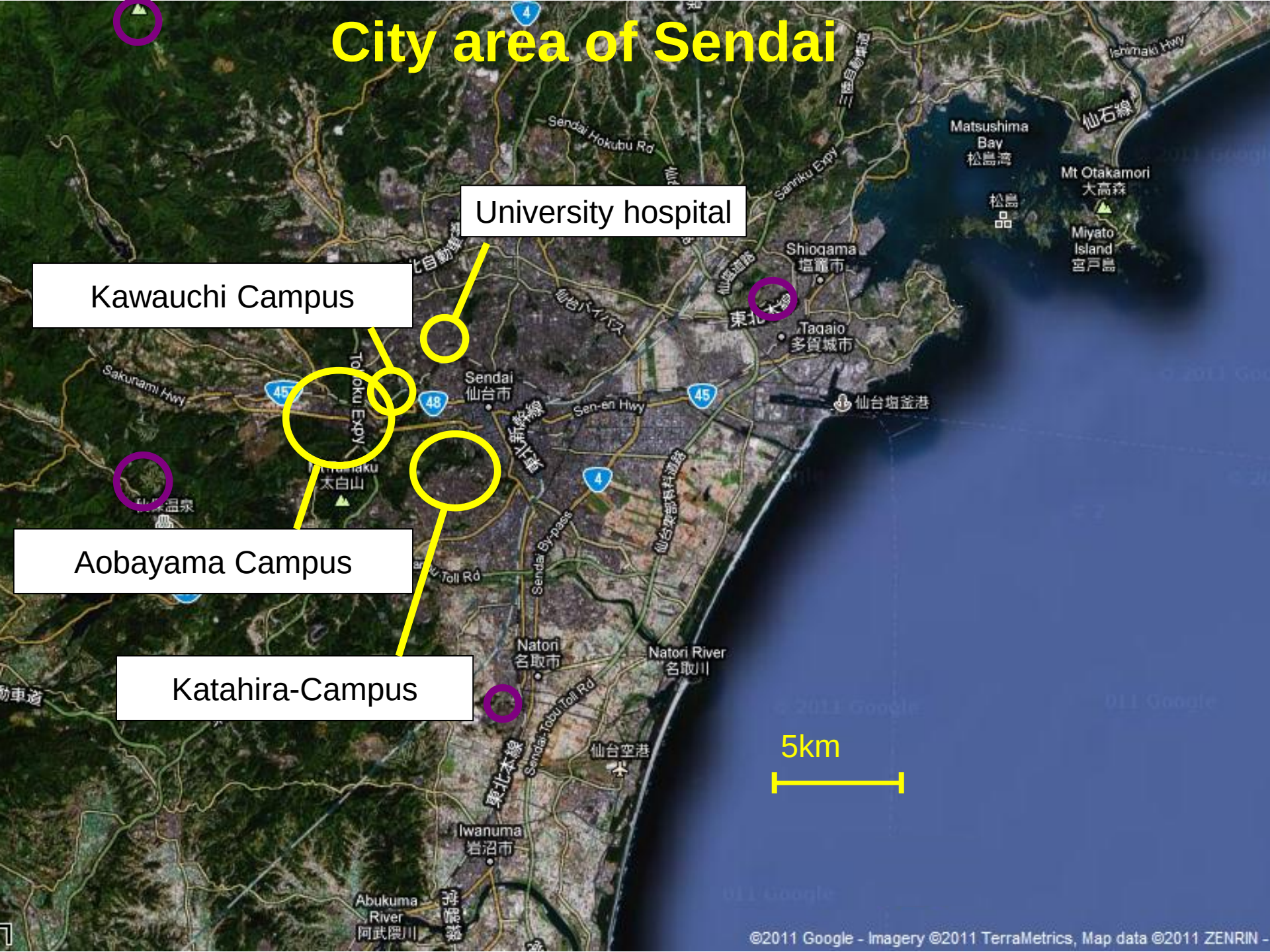
Tsunami hight

7m – over 28.4m

„More than 5 times“

(Japan Meteorological Agency)


City area of Sendai
Sendai Hokubu Rd
Sanriku Expy
Matsushima Bay
松島湾
Mt Otakamori
大高森
Miyato Island
宮戸島
Shiogama
塩竈市
東北本線
Tagajo
多賀城市
Sakunami Hwy
Tohoku Expy
Sendai
仙台市
Sen-en Hwy
仙台塩釜港
Mt Taihaku
太白山
秋保温泉
Sendai Nanbu Toll Rd
Sendai By-pass
Natori
名取市
Natori River
名取川
仙台空港
Sendai-Tobu Toll Rd
Iwanuma
岩沼市
Abukuma River
阿武隈川
5km
©2011 Google - Imagery ©2011 TerraMetrics, Map data ©2011 ZENRIN


City area of Sendai
University hospital
Kawauchi Campus
Aobayama Campus
Katahira-Campus
5km
Sendai
仙台市
Shiogama
塩竈市
Taqaio
多賀城市
Matsushima Bay
松島湾
Mt Otakamori
大高森
Miyato Island
宮戸島
Natori
名取市
Natori River
名取川
Iwanuma
岩沼市
Abukuma River
阿武隈川
仙台空港
仙台塩釜港
Sendai Hokubu Rd
Sanriku Expy
Sakunami Hwy
Tohoku Expy
Sen-en Hwy
Senda By-pass
Sendai-Tobu Toll Rd
Ishinaki Hwy
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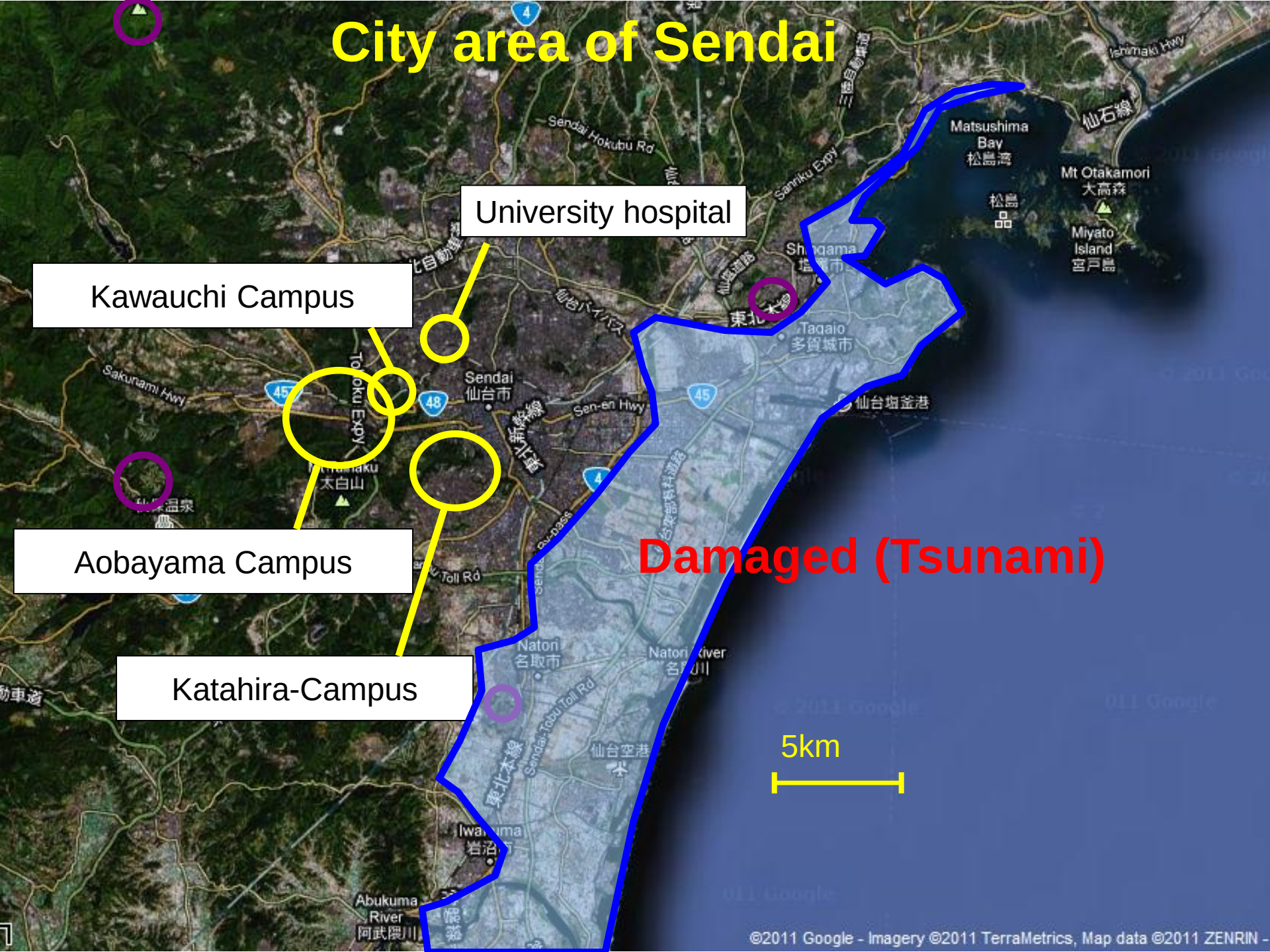
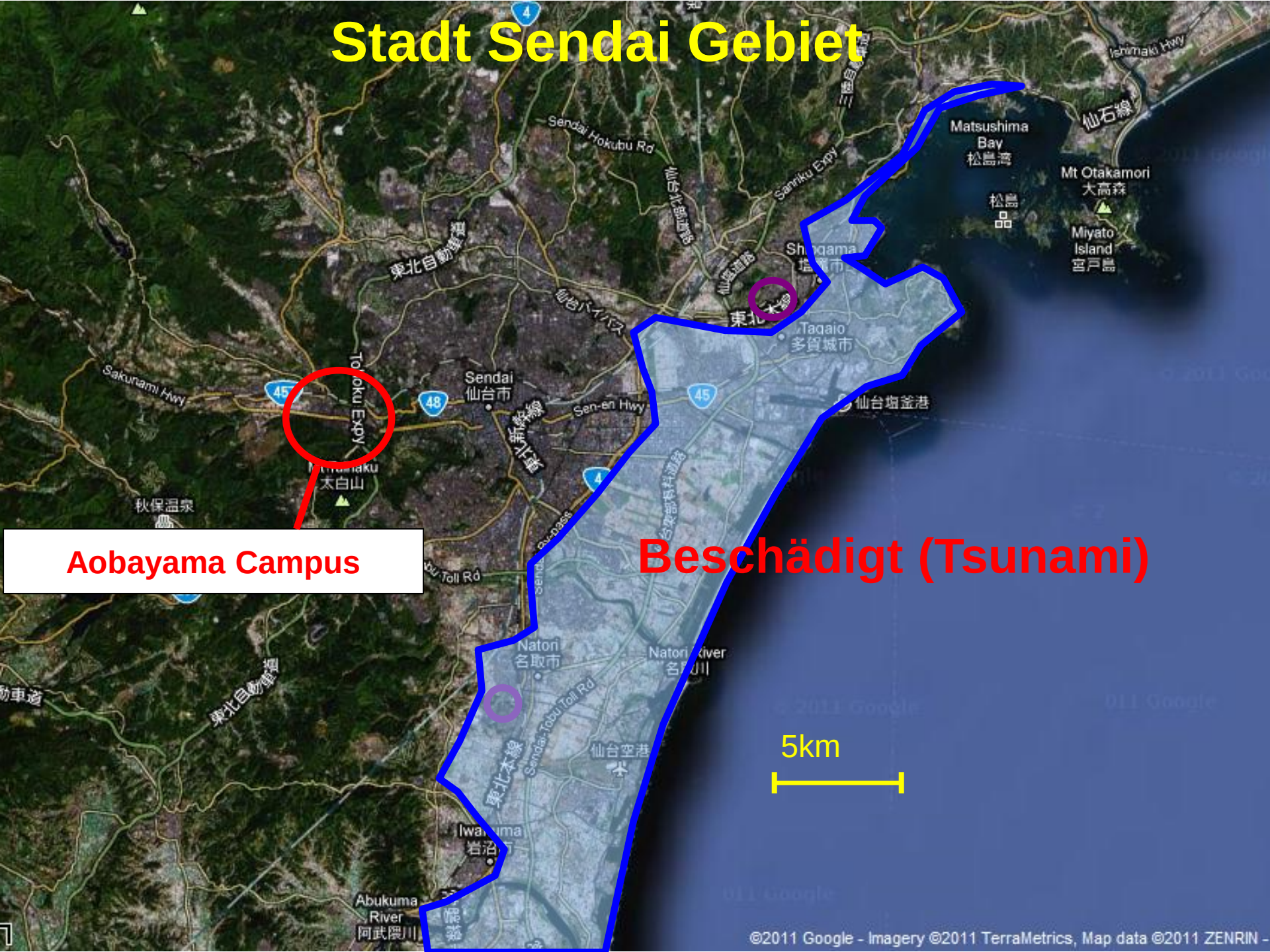
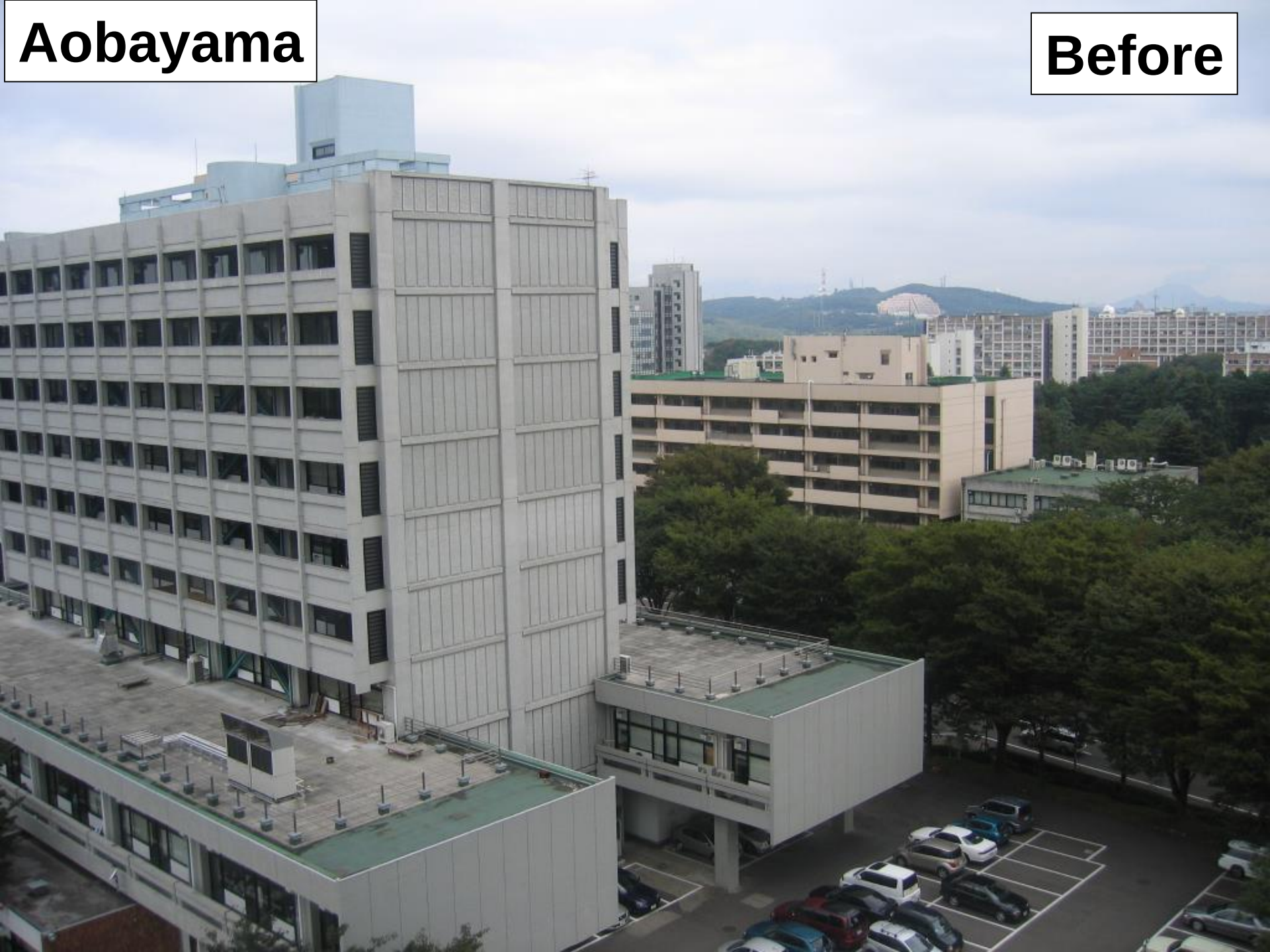
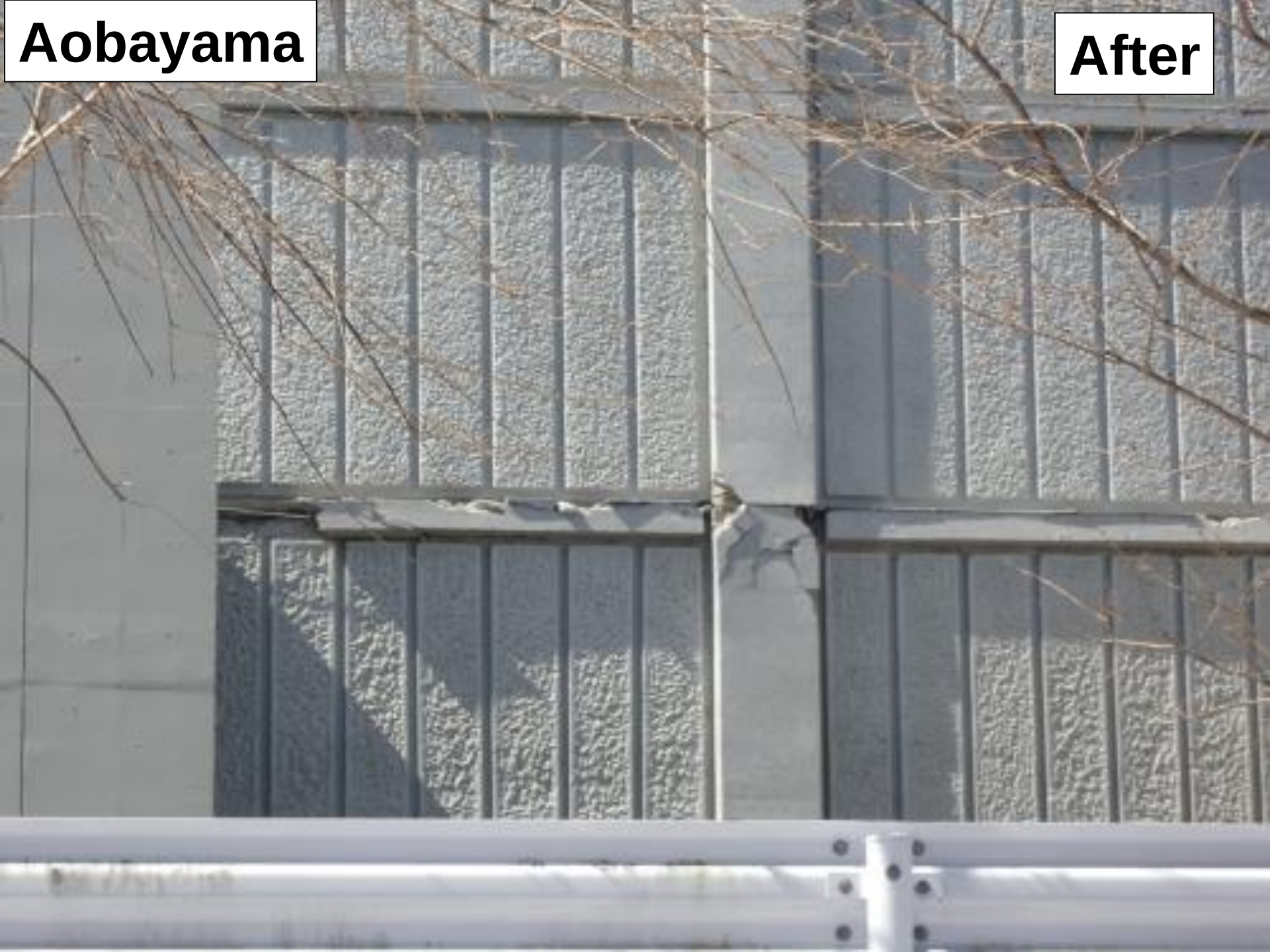

City area of Sendai
University hospital
Kawauchi Campus
Aobayama Campus
Katahira-Campus
Damaged (Tsunami)
5km
Sendai
仙台市
Natori
名取市
Tagajo
多賀城市
Matsushima Bay
松島湾
Mt Otakamori
大高森
Miyato Island
宮戸島
Sendai Hokubu Rd
Sanriku Expy
Ishinomaki Hwy
Sakunami Hwy
Tohoku Expy
Sen-en Hwy
Sendai-Tobu Toll Rd
仙台空港
仙台塩釜港
Abukuma River
©2011 Google - Imagery ©2011 TerraMetrics, Map data ©2011 ZENRIN


Stadt Sendai Gebiet
Aobayama Campus
Beschädigt (Tsunami)
5km
Sendai
仙台市
Natori
名取市
Tagajo
多賀城市
Matsushima Bay
松島湾
Mt Otakamori
大高森
Miyato Island
宮戸島
Sendai Hokubu Rd
Sanriku Expy
Tohoku Expy
Sakunami Hwy
Sen-en Hwy
Ishinomaki Hwy
Natori River
Abukuma River
仙台空港
仙台塩釜港
秋保温泉
太白山
©2011 Google - Imagery ©2011 TerraMetrics, Map data ©2011 ZENRIN -

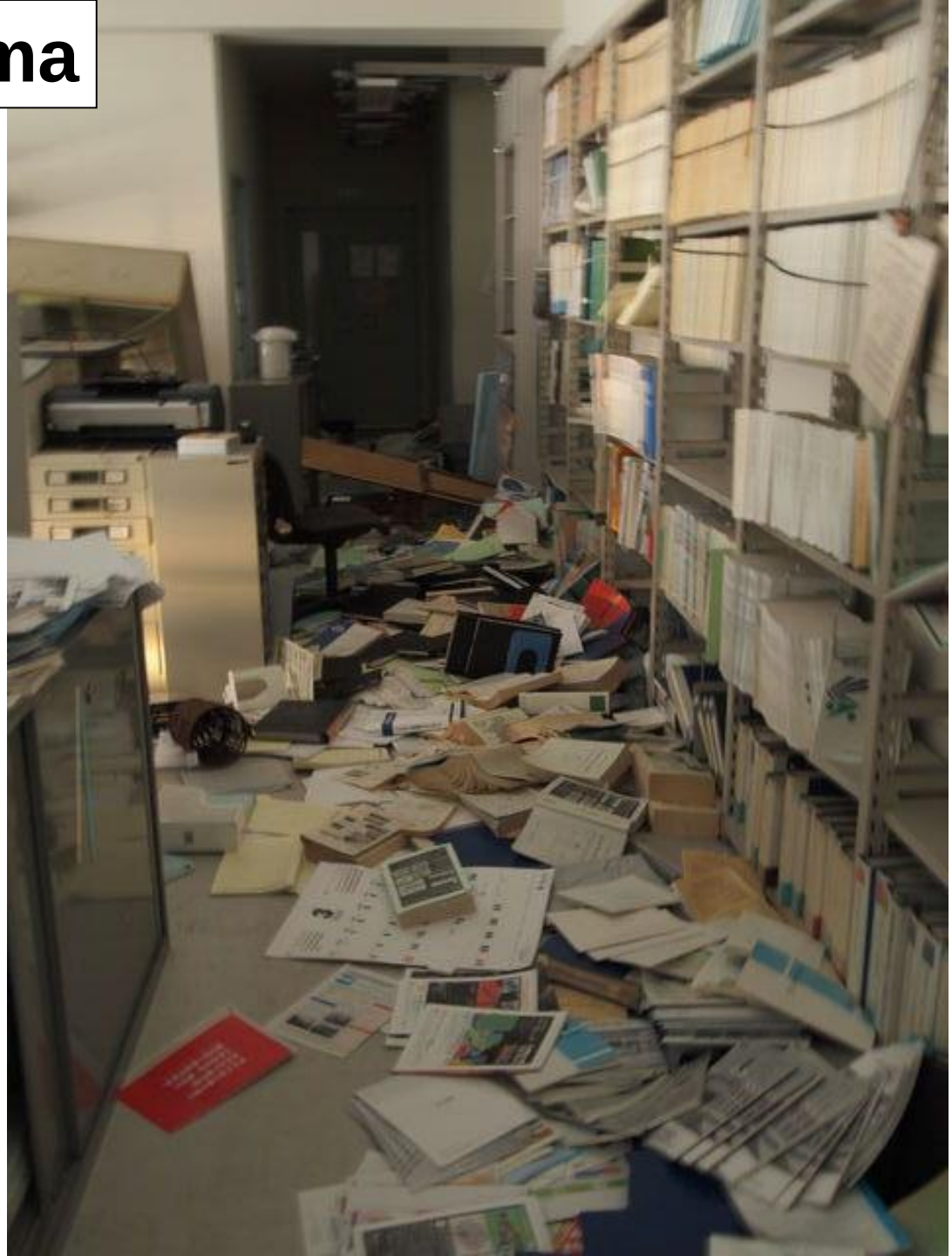

Aobayama
Before


Aobayama
After


Aobayama
After


Aobayama
After

Aobayama



After

Aobayama

After


Sendai area
Shiogama
Tagajo
Damaged (Tsunami)
5km
Matsushima Bay
松島湾
Mt Otakamori
大高森
Miyato Island
宮戸島
Sendai Hokubu Rd
Sanriku Expy
Ishinomaki Hwy
Tohoku Expy
Sakunami Hwy
Sendai
仙台市
Sen-en Hwy
Mt Taihaku
太白山
秋保温泉
Sendai Nanbu Toll Rd
Natori
名取市
Natori River
名取川
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仙台空港
Iwanuma
岩沼
Abukuma River
阿武隈川
仙台塩釜港
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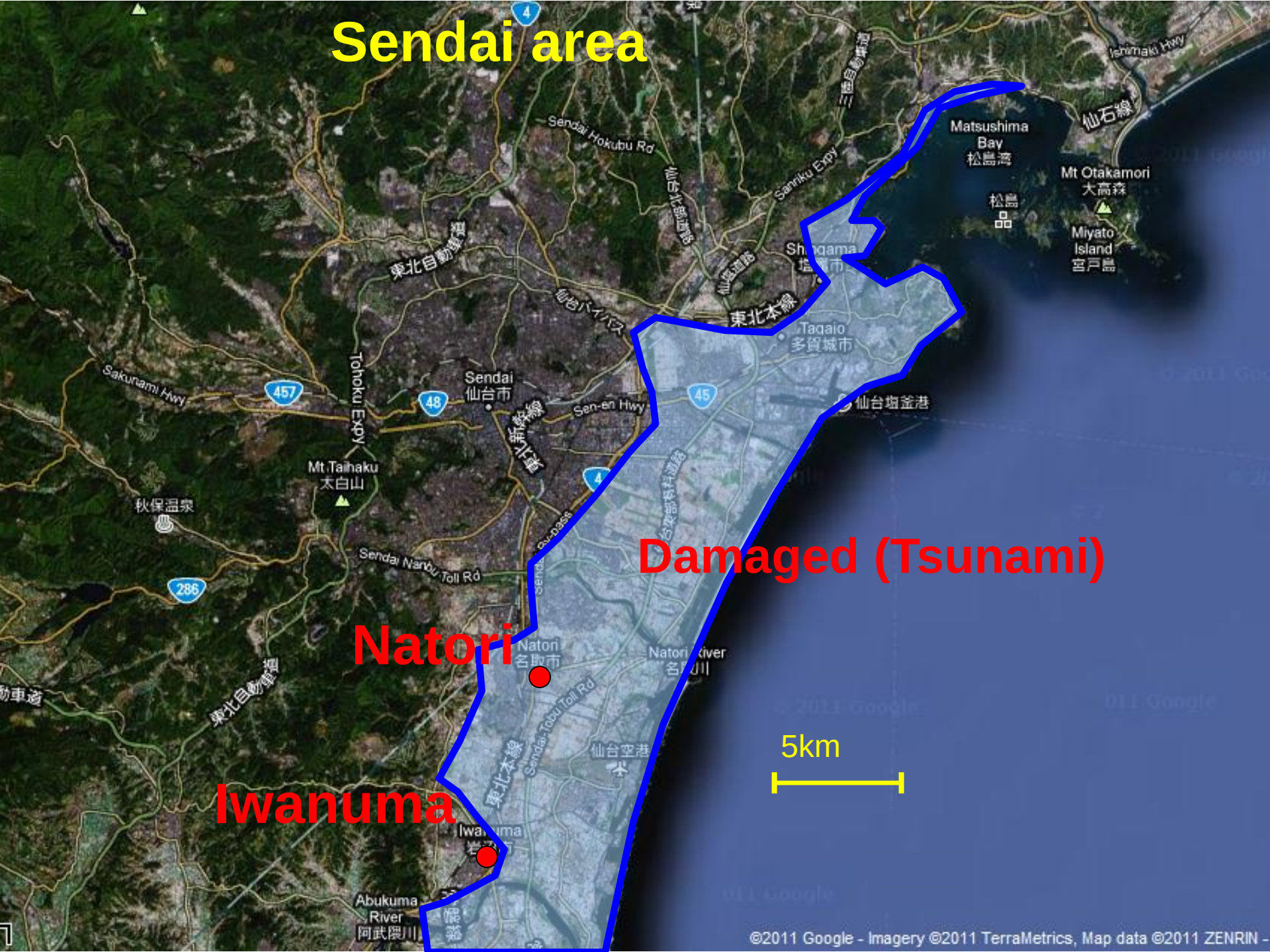
Shiogama
After


Tagajo
After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Sendai Hokubu Rd
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Ishinomaki Hwy
東北自動車道
東北本線
仙台バイパス
Tohoku Expy
Sendai
仙台市
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阿武隈川
Taqaio
多賀城市
仙台塩釜港
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Natori-Iwanuma

Tsunami

Tsunami

Natori-Iwanuma

Sendai airport.

Tsunami

Natori-Iwanuma

After

Natori-Iwanuma

After


Onagawa
Ishinomaki
HigashiMatsushima
5km
Higashimatsushima
東松島市
Ishinomaki
石巻市
石巻港
Mangokuura
Sea
万石浦
Ishinomaki
Bay
石巻湾
Matsushima
Bay
松島湾
Mt Otakamori
大高森
松島
Miyato
Island
宮戸島
Shiogama
塩竈市
Tagajo
多賀城市
仙台塩釜港
Oshika
Peninsula
牡鹿半島
Kinkasan
Island
金華山
東北新幹線
東北本線
仙石線
Sanriku Expy
Ishinomaki Hwy
女川街道
45
108
346
398
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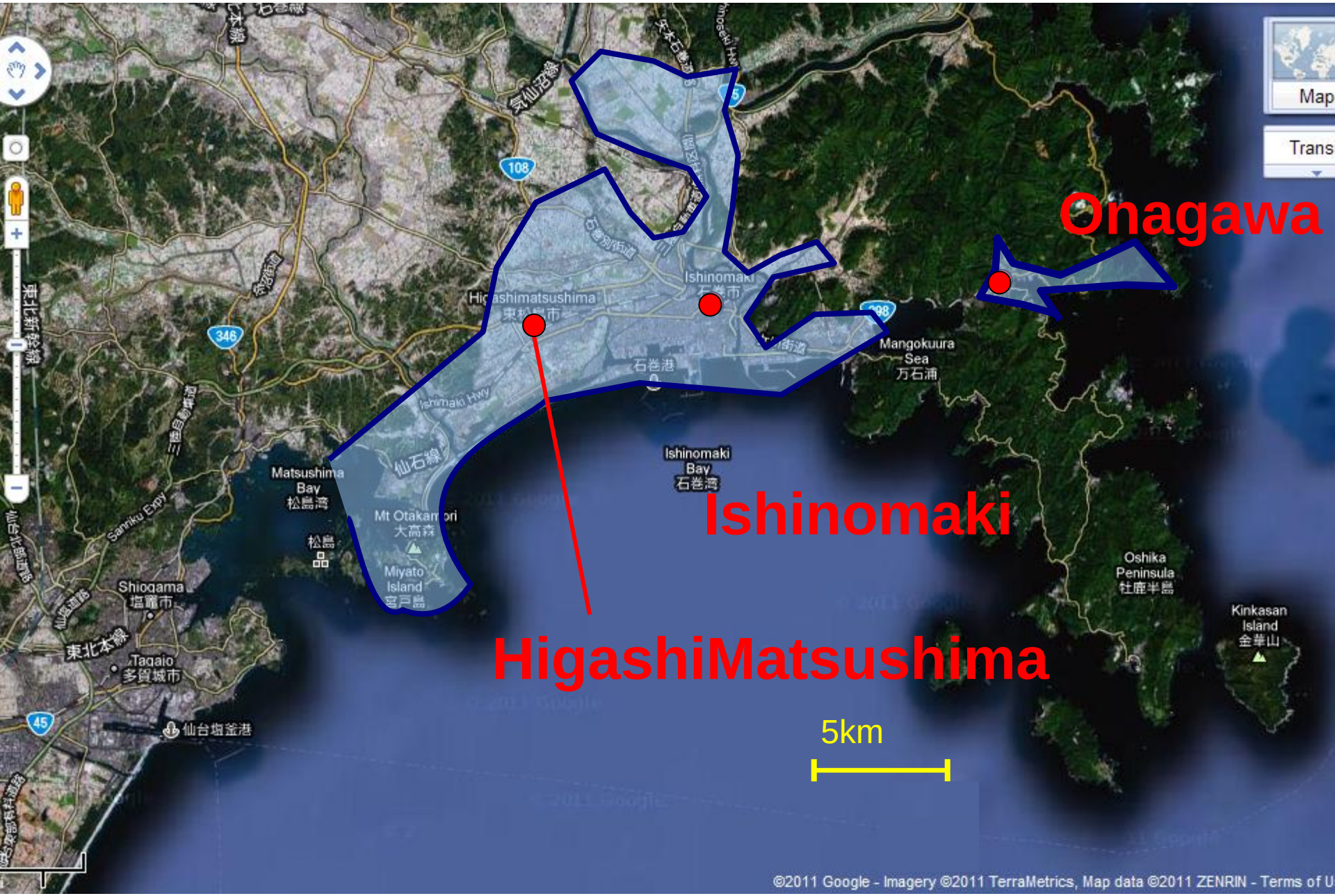
Onagawa
Ishinomaki
HigashiMatsushima
5km
Ishinomaki Bay
石巻湾
Matsushima Bay
松島湾
Mangokuura Sea
万石浦
Oshika Peninsula
牡鹿半島
Kinkasan Island
金華山
Miyato Island
宮戸島
Shiogama
塩竈市
Tagajo
多賀城市
仙台塩釜港
Ishinomaki Hwy
Sanriku Expy
東北新幹線
東北本線
仙石線
石巻港
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Onagawa
Before

Onagawa

After

Onagawa

After

Onagawa

After

Rikuzentakata

Before

Tsunami


Rikuzentakata
Tsunami


Rikuzentakata
Tsunami


Rikuzentakata
Tsunami

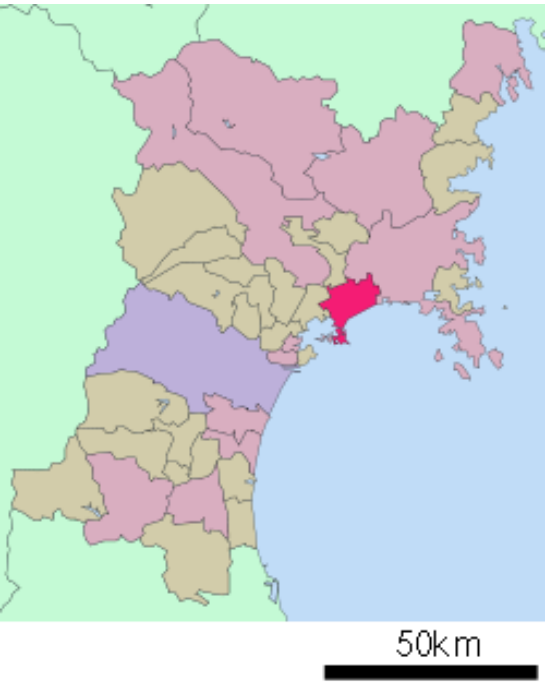

Rikuzentakata
Tsunami

Anti-Tsunami tactics by Masamune Date

60km length canal at coast shielded by „Pine-tree stripe“

Sendai city was made after Tsunami disaster (about 400 years ago)

Reconstruction in Higashi-Matsushima city



Population: about 40,000

Area: 101,4 km²

Reconstruction in Higashi-Matsushima city

Assistance by Denmark

- "Higashi-Matsushima - Denmark Friendship Children Fund"
- Enhance human resources development
- People-to-people exchange, care and education

Visit of the Prince in Jun. 2011 and Oct.2017

Reconstruction in Higashi-Matsushima city

As the norm Denmark, Higashi-matsushima city made reconstruction plan, introducing renewable energy actively.

- Attraction of enterprises
- Creation of employment
- Local production of energy for local consumption

Mega-solar plant

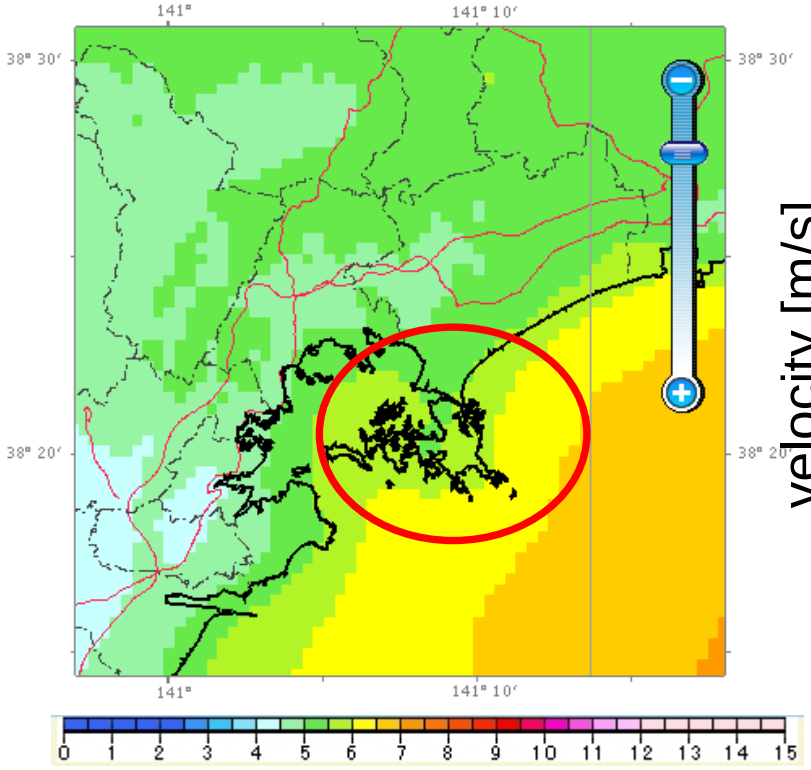
Smart city

Tsunami evacuation tower

Natural energy resource in Higashi-Matsushima

Wind

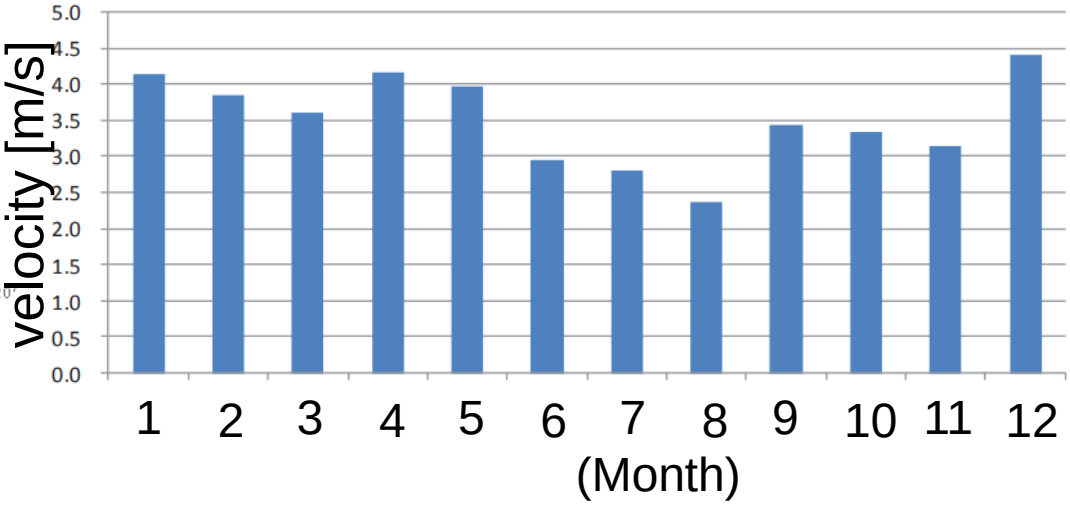
Velocity distribution (average)



Wind velocity [m/s]

NEDO
http://app8.infoc.nedo.go.jp/nedo/webgis

Seasonal variation

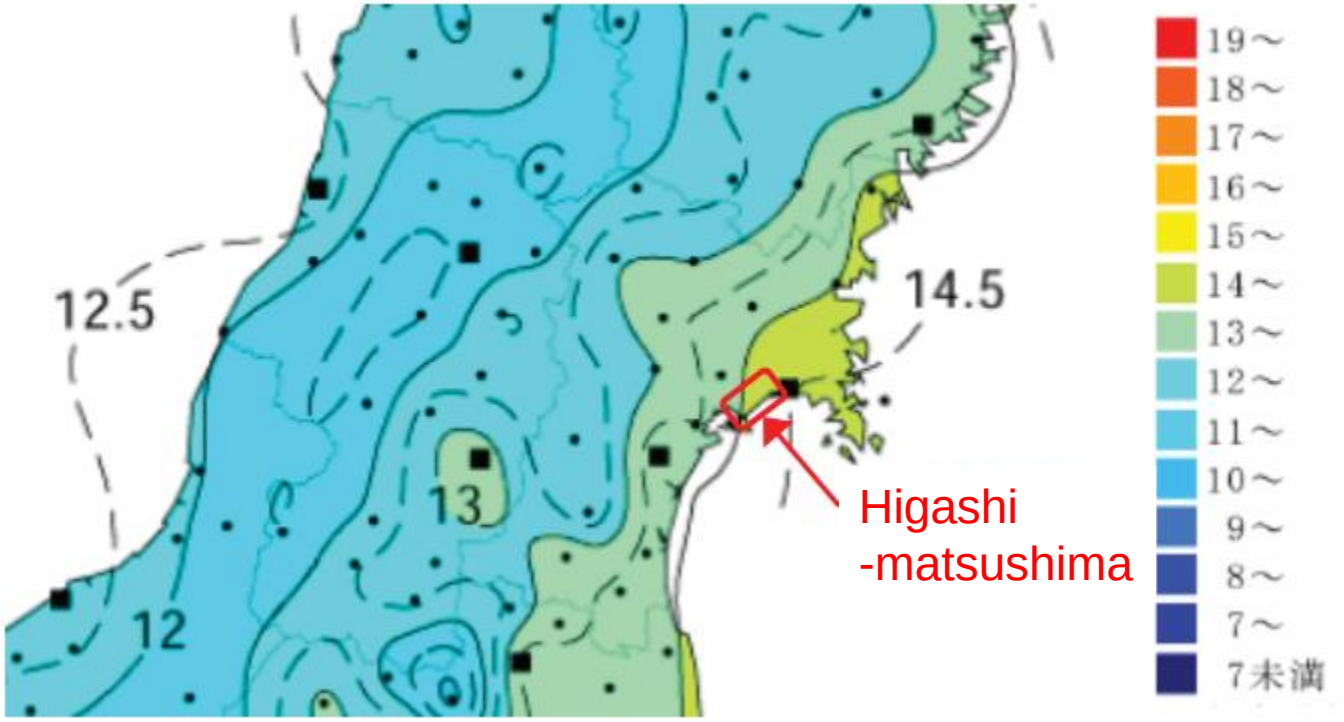


Higashi-matsushima energy vision
http://www.city.higashimatsushima.miyagi.jp/

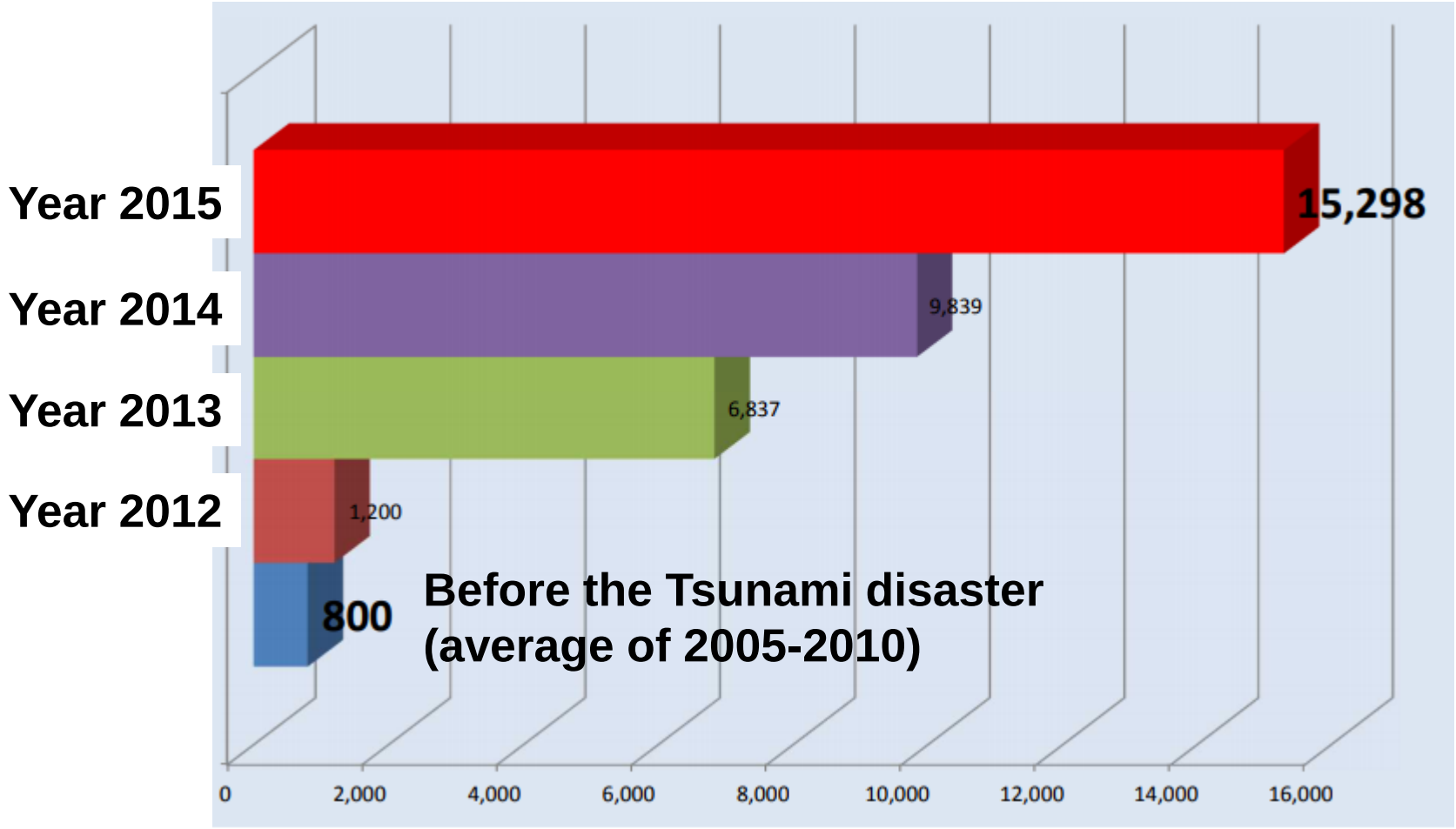
Natural energy resource in Higashi-Matsushima

Solar

insolation (annual) [MJ/m^2]



Generated electricity (RE based) in Higashi-matsushima city



Published by Higashi-matsushima city
https://www.env.go.jp/press/y0618-05/mat05_1.pdf

Reconstruction of Higashi-matsushima city

Recycling

- Amount of debris generated by Tsunami amounted to 1,098,000 t in Higashi-matsushima. This corresponds to the amount **for 110 years**.

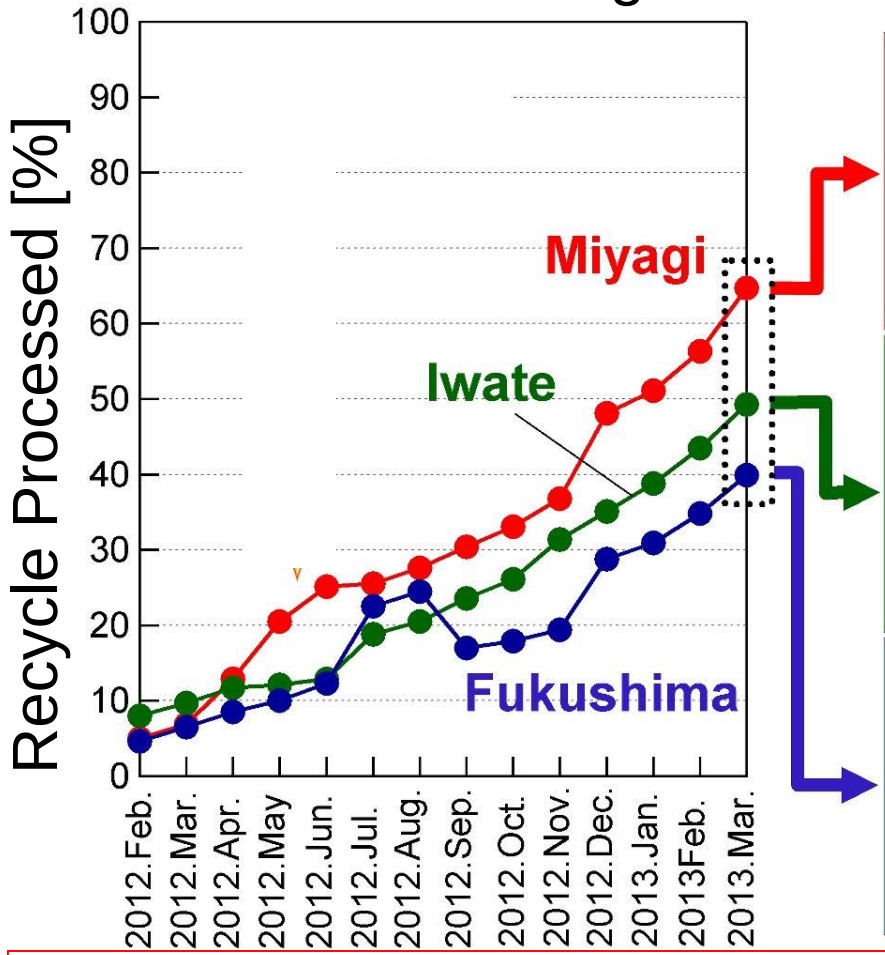
- Recycled rate was 99.22% of the whole



- Industry, City and Citizens cooperated for the future of Higashi-Matsushima city.

Recycle percentzge of „Tsunami-debri“ at strongly damaged prefectures

Transition of the debri handling

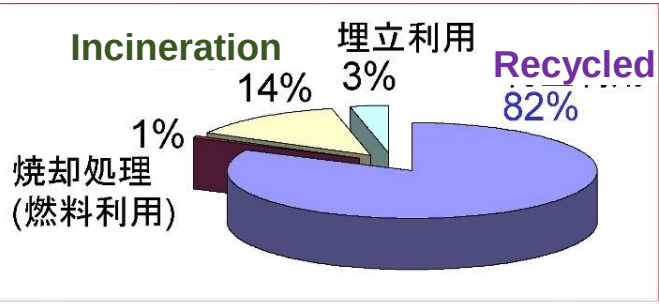


Amount of debri

Detailed

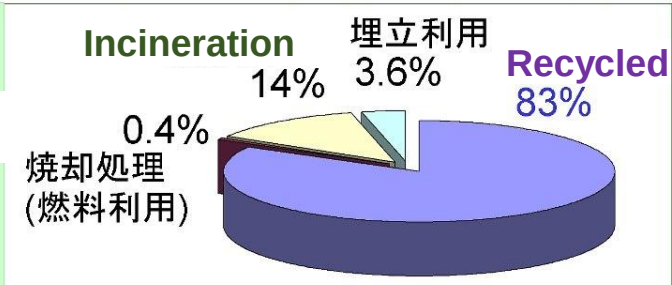
Miyagi

Total amount [x1000ton]	Processed [x1000ton]
10,456	6,761



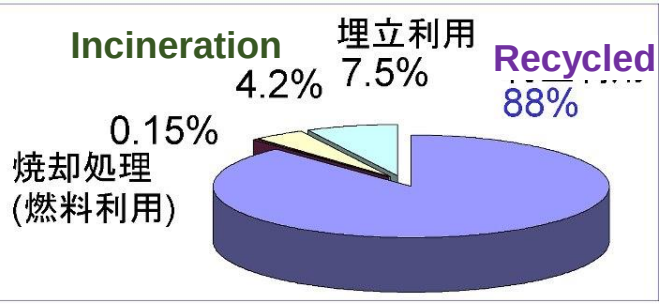
Iwate

Total amount [x1000ton]	Processed [x1000ton]
3,659	1,802



Fukushima

Total amount [x1000ton]	Processed [x1000ton]
1,701	679



Miyagi and Iwate: 99%, Fukushima:94% (as of Nov.2017)

Lessons from 3.11 disaster(tsunami) and reconstruction

- Eenergy security
- „Reconstruction“ is not „Recovery“
- We have to think about the future.
  To think about the future, learning from history is also important.
- Fukushima NPP: Rethink Eenergy security and Energy policy

Two Social Impacts Affected on Energy Policy in Japan

1. Heavy pollution in the 50s to 70s

- Environmental Agency (1971)
- Ministry of the Environment (2001)

2. The Fukushima nuclear accident (spreading radioactive contaminations and pollution) in 2011

- Wake-up call to rethink of energy
- Promotion of RE and hydrogen energy

1st social impact:

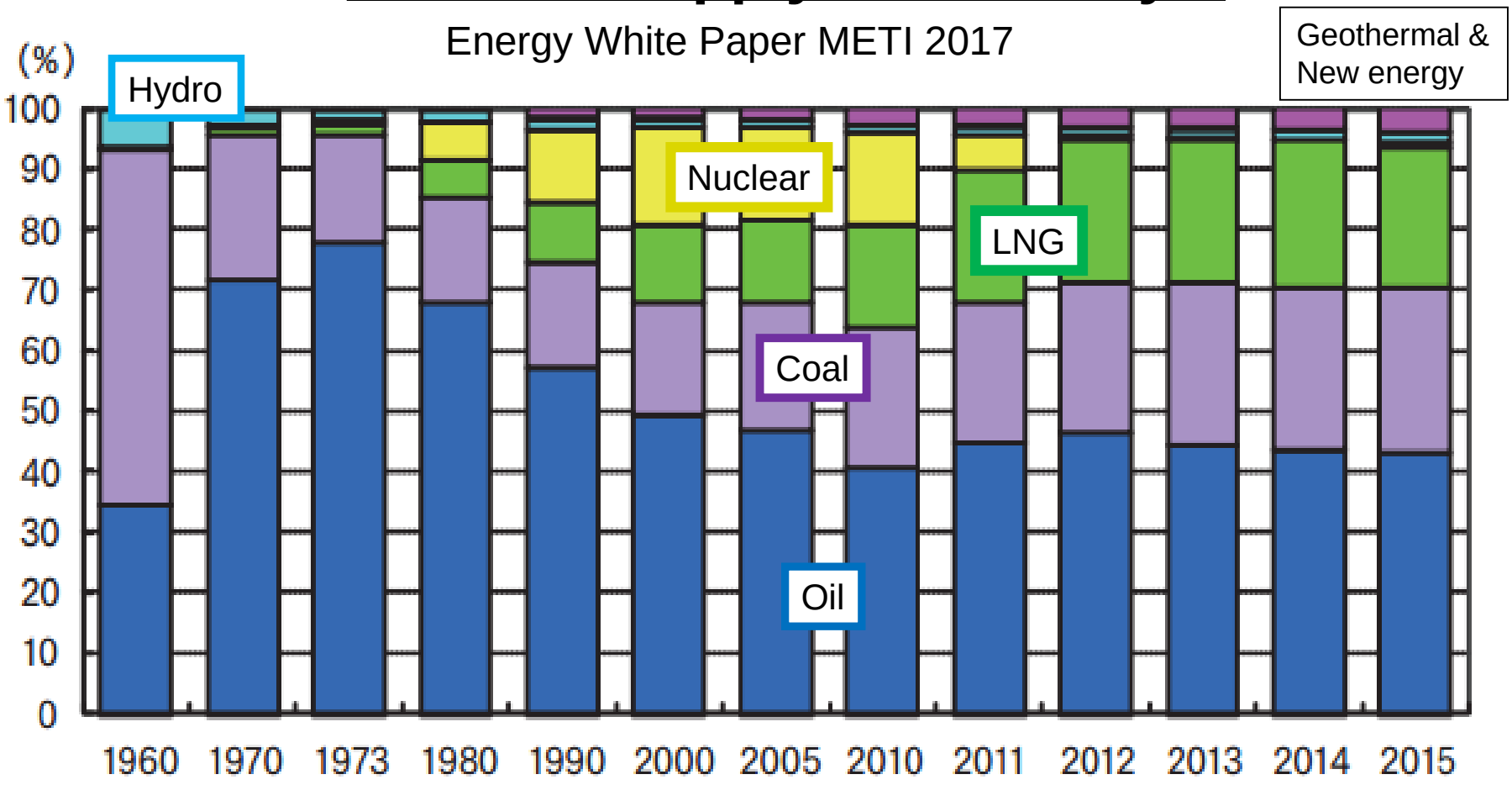
Heavy Air and Water Pollutions throughout Japan

Rapid Growth in Economy and
Industrial Development from 1950s to 70s.

- Strong dependency of the primary energy upon import
- Self-Sufficiency = 6% (in 2016)

Japan's Primary Energy Supply Structure and Self-Supply Sufficiency

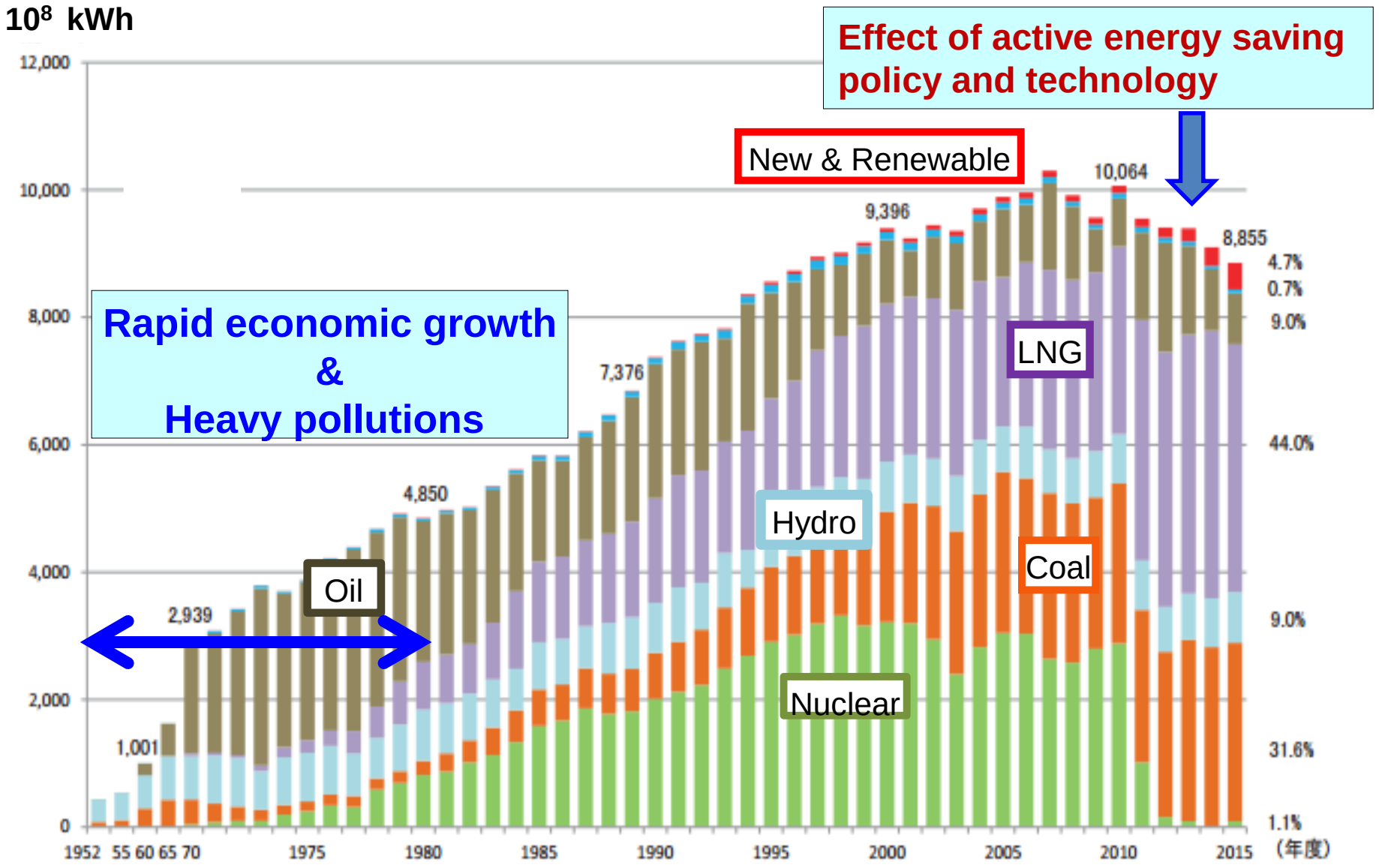
Energy White Paper METI 2017



Self-supply sufficiency

1960	1970	1973	1980	1990	2000	2005	2010	2011	2012	2013	2014	2015
58.1	15.3	9.2	12.6	17.0	20.2	19.1	19.9	11.1	6.2	6.1	6.0	7.0

Power Supply Configuration in Japan (2017 METI)

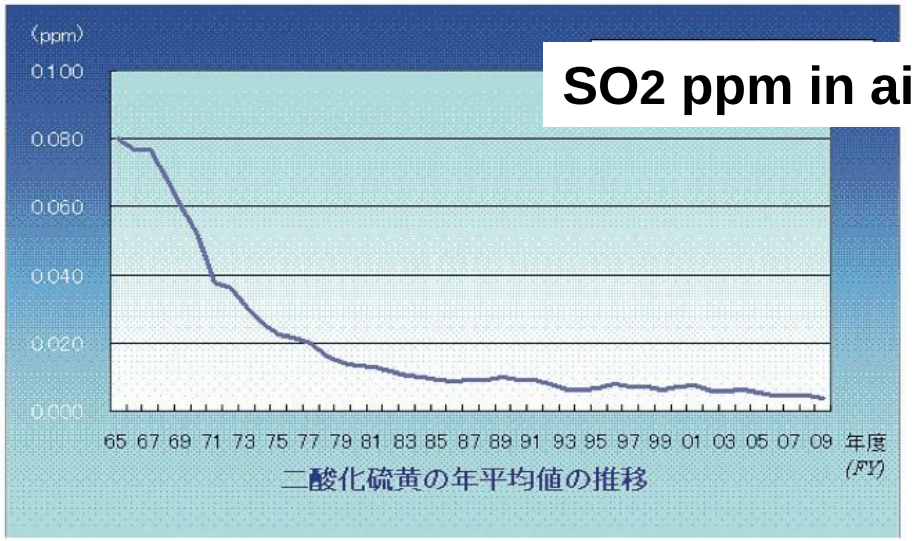


Kawasaki Industrial Area in Kanagawa Prefecture

Kawasaki was one of the most polluted cities as the largest heavy industrial area in Japan, since 1950s

1960s

2015



SO2 ppm in air

KAWASAKI CITY

Kawasaki was one of the most polluted cities as the largest heavy industrial area in Japan, since 1950s

TAMA River in Kawasaki

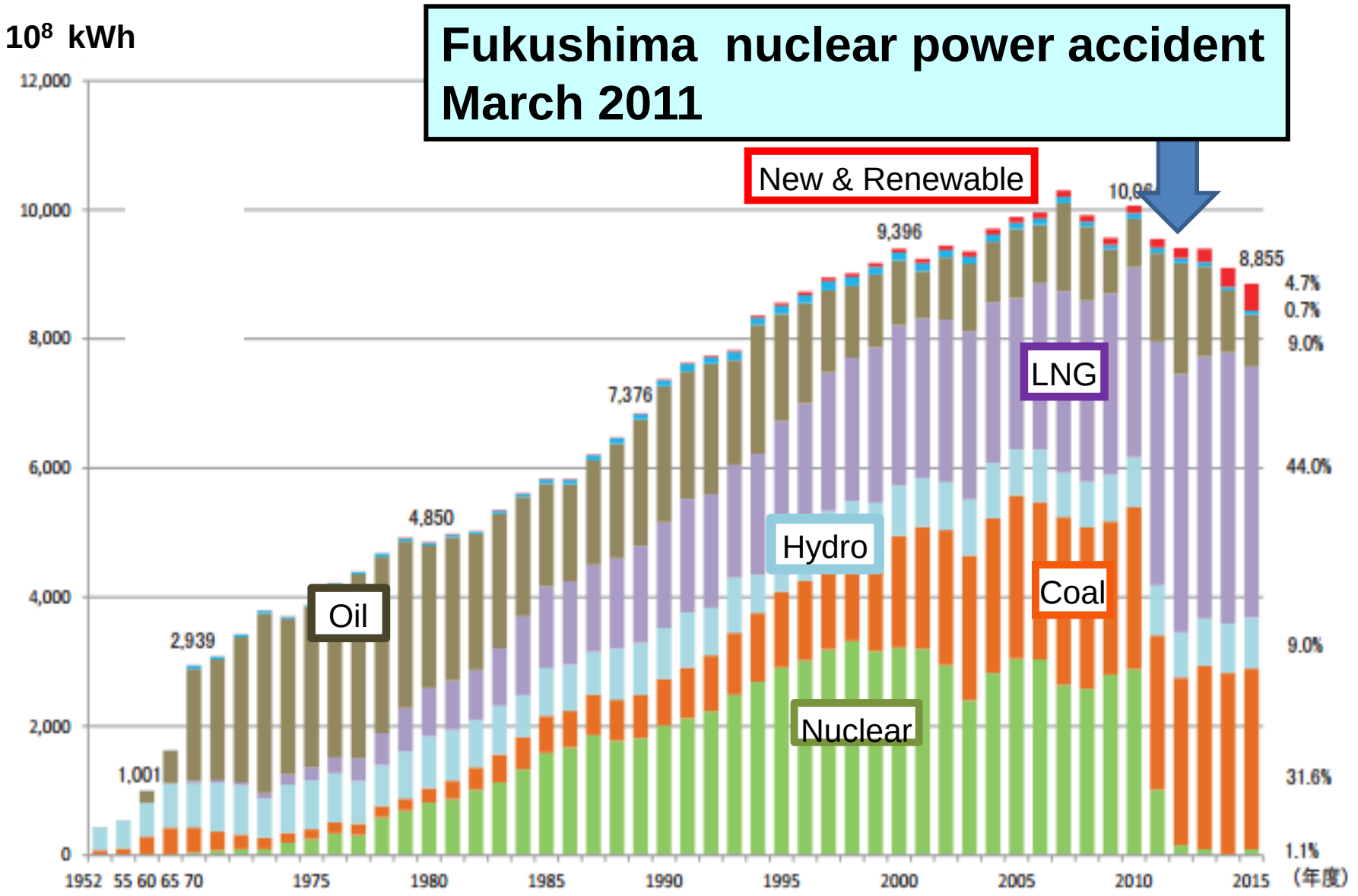
1970

2015

2nd social impact:

The Fukushima Nuclear accident in March 2011, and radio active pollution

Power Supply Configuration in Japan (2017 METI)



What happened at Fukushima on and after 11th March 2011

Tsunami attack

Melt down & through
=> Hydrogen explosion

Destroyed and contaminated plants
Removal of U-debris needs over 40 years

Examination of radioactive contaminations

The Fukushima nuclear accident was a wake-up call for the Japanese people to rethink energy

Changing attitude of Japan's energy policy:

- ***Reduction to Nuclear Power Dependence***
- ***Acceleration of Spread of RE, and Change in Industrial Policy towards Realization of H-Society***

- ***Going with the global environmental action : CO_2 reduction & Prevention of Global Warming***

. **The government announced**

“2015 is the start of the hydrogen era for Japan”.

Prime Minister S. Abe

Active Tackling on Hydrogen in Japan

1. Japan experienced **serious pollutions** in the 50s to 70s.
2. **The nuclear disaster and radioactive pollution** were recent impact. About 120,000 people are forced to evacuate from home even at present.
3. **Governmental S+3E Policy :**

Safety + Energy-Security, Economic Growth, Environmental Protection

Civic level => 3R : *Reduce/Reuse/Recycle Actions*

Active Tackling on Hydrogen in Japan

4. Japan will contribute to global environment and to realization of low carbon society

by tackling on developing diverse technologies of energy creation, storage and saving

=> Balance among Environmental Constraints and Economic Growth --- COP21 Paris Agreement

5. The commercialization of diverse hydrogen technologies combined with accumulated high-techs *should promote*

new industry, new market and economy.

Active Tackling on Hydrogen in Japan

6. Since the 70s, Japan has been active with the R&D of hydrogen energy by collaboration among academic-industrial-governmental sectors.

The 8th World Hydrogen Technology Convention (WHTC 2019), Tokyo is being prepared*, just one year before *Tokyo Olympics and Paralympics Games 2020.

The Japanese government and City of Tokyo will demonstrate you what hydrogen can.

You can watch, touch and feel diverse hydrogen technologies and new products in Tokyo.

Japan's Energy Mixture Plan of Power Configuration in 2030

- **Renewable Energy = 22 to 24%**

  Geothermal:1~1.1% + Biomass:3.7~4.6% + Wind:1.7% + Solar:7% + Hydro:8.8~9.2%

- **Nuclear Power = 20 to 24%**

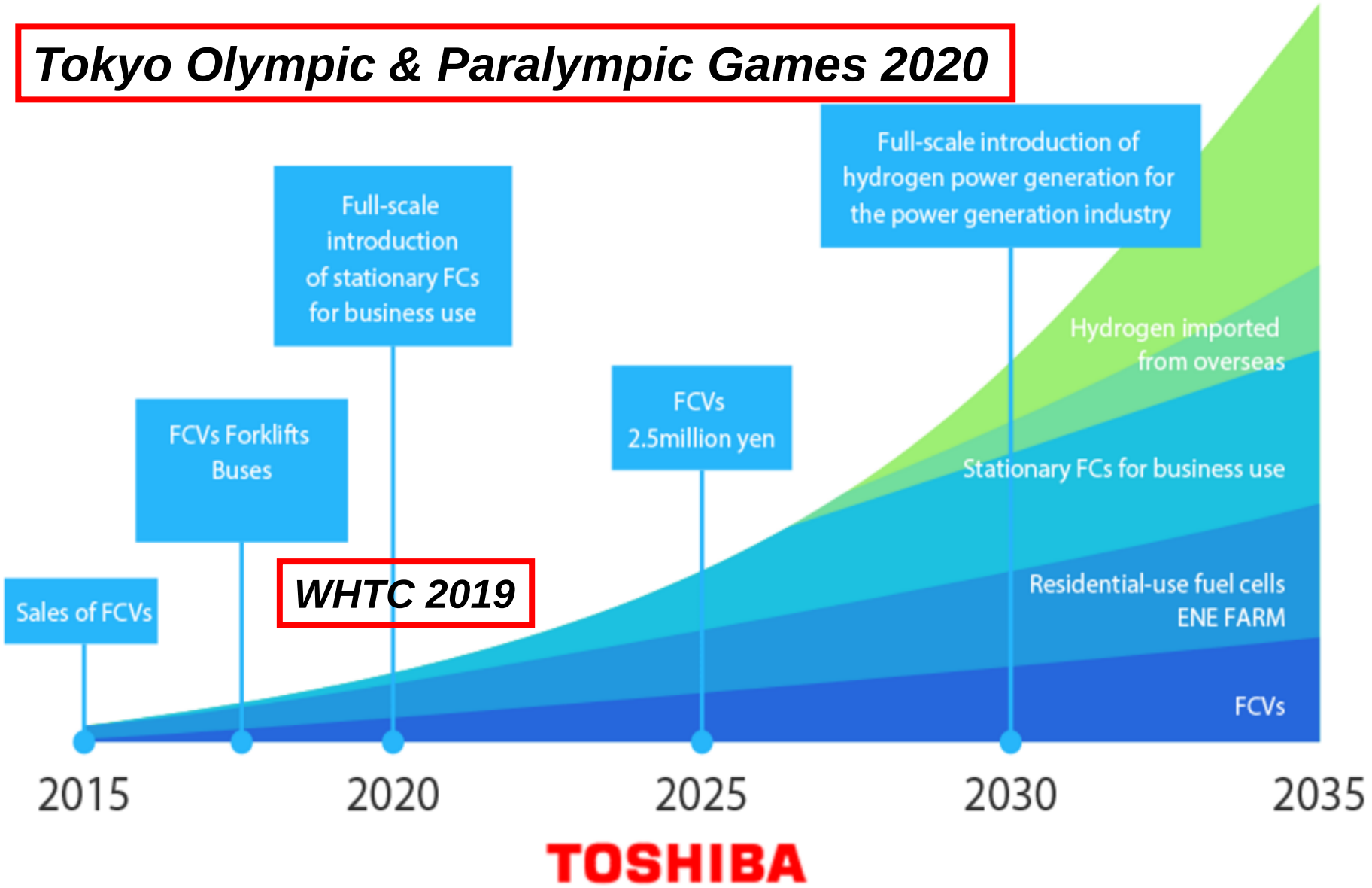
  ***)Reactivation of nuclear power plants older than 40 years is needed.**
  4 of 52 NPPs are in active in July 2017.

- **Fossil Thermal Power = 56%**

  LNG:27% + Coal:26% + Oil:3%

Energy White Paper 2017 METI

Hydrogen demand in Japan will increase rapidly



TOSHIBA

Transport of H_2 from abroad

where abundant cheap CO_2 free H_2 can be produced by renewable energy.

1) **L-H_2 by tanker,** ***Kawasaki Heavy Industry***
2) **MCH (methyl Cyclohexane= Toluene + H) by tanker,** ***Chiyoda Corporation***
3) **Use of NH_3 distribution systems**

*) *Dr. S. Kimura, Program Director of* ***SIP***, reports details.

SIP: Cross-ministerial Strategic Innovation Promotion Program, Japan.

Hydrogen price : JPY90/Nm^3 at present should be reduced down to JPY30/Nm^3 by 2020 => JPY17/kWh electric power generation.

FC Technology Leading Hydrogen Business

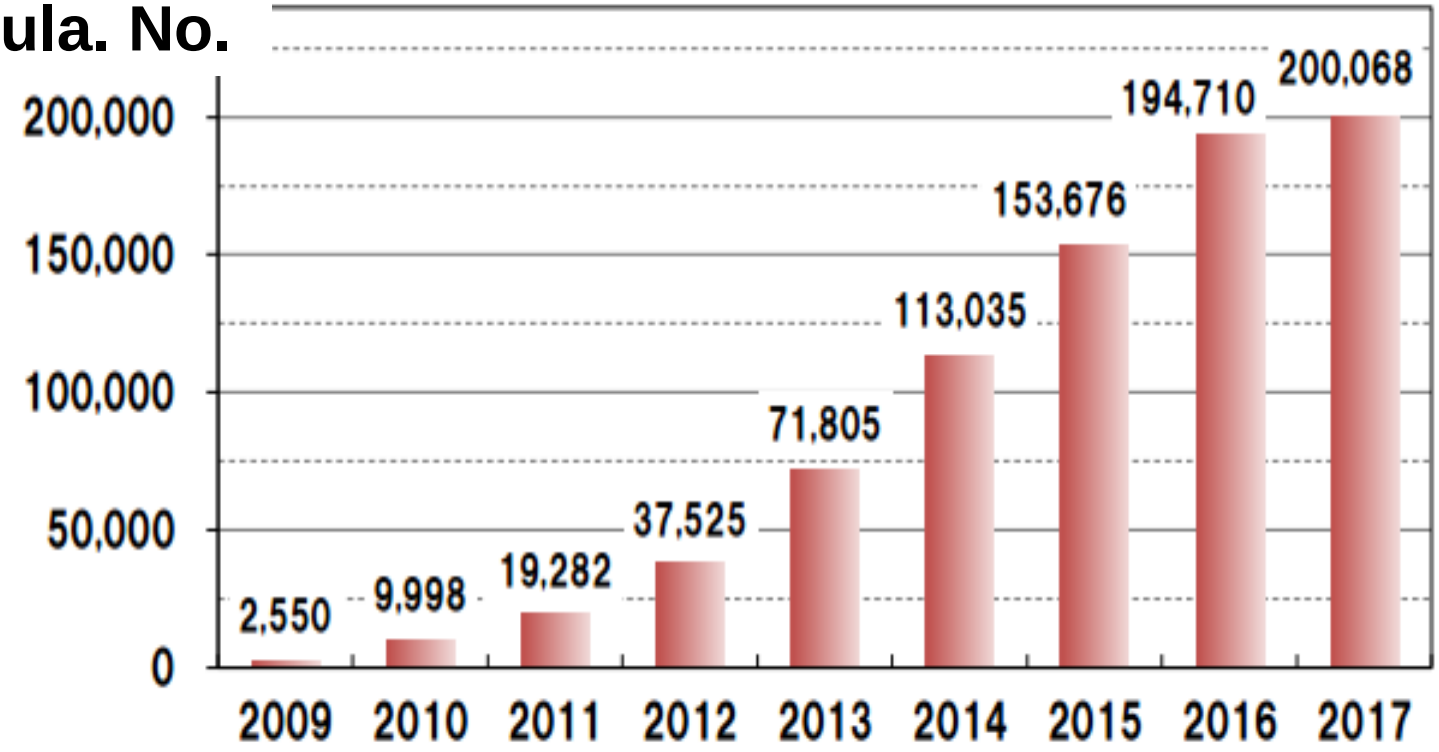
Cumulative number of sale has exceeded 200,000 in May 2017

Remote control that can connect with a smartphone

Stationary Use = ENE FARM

Price: JPY=1.5 million/unit 700W

Cumula. No.



FC Technology Leading Hydrogen Business

Mobile Use

Active Motor Companies

&

Hydrogen Supply Companies

and relevant companies

HONDA

Small & Smart H_2 Supply

HONDA + IWATANI towards Eco-Technology

HONDA SHS = Smart Hydrogen Station as a Compact Package

Production rate:

200VAC + H_2O =>

2.5kgH_2 per day

H_2 purity > 99.99%

Storage capacity: 18kgH_2

***) FCV max driving range = 60~100 Km/kgH_2; JPY1100/kgH_2**

HONDA SHS Easy Setting Up within a Day

Footprint: 10 to 20%, and cost :
10% of a conventional big H2 station

1日で設置できる「スマート水素ステーション」


設置場所では予め基礎工事を行い、電気や水道の配管を準備しておく


工場で組み立てた「スマート水素ステーション」をトラックで搬入


「スマート水素ステーション」をクレーンで吊り上げてトラックからから下ろす


基礎工事を終えた設置場所に配置


カバーなどを取り外す


しっかりと固定するとともに、電気や水道を接続

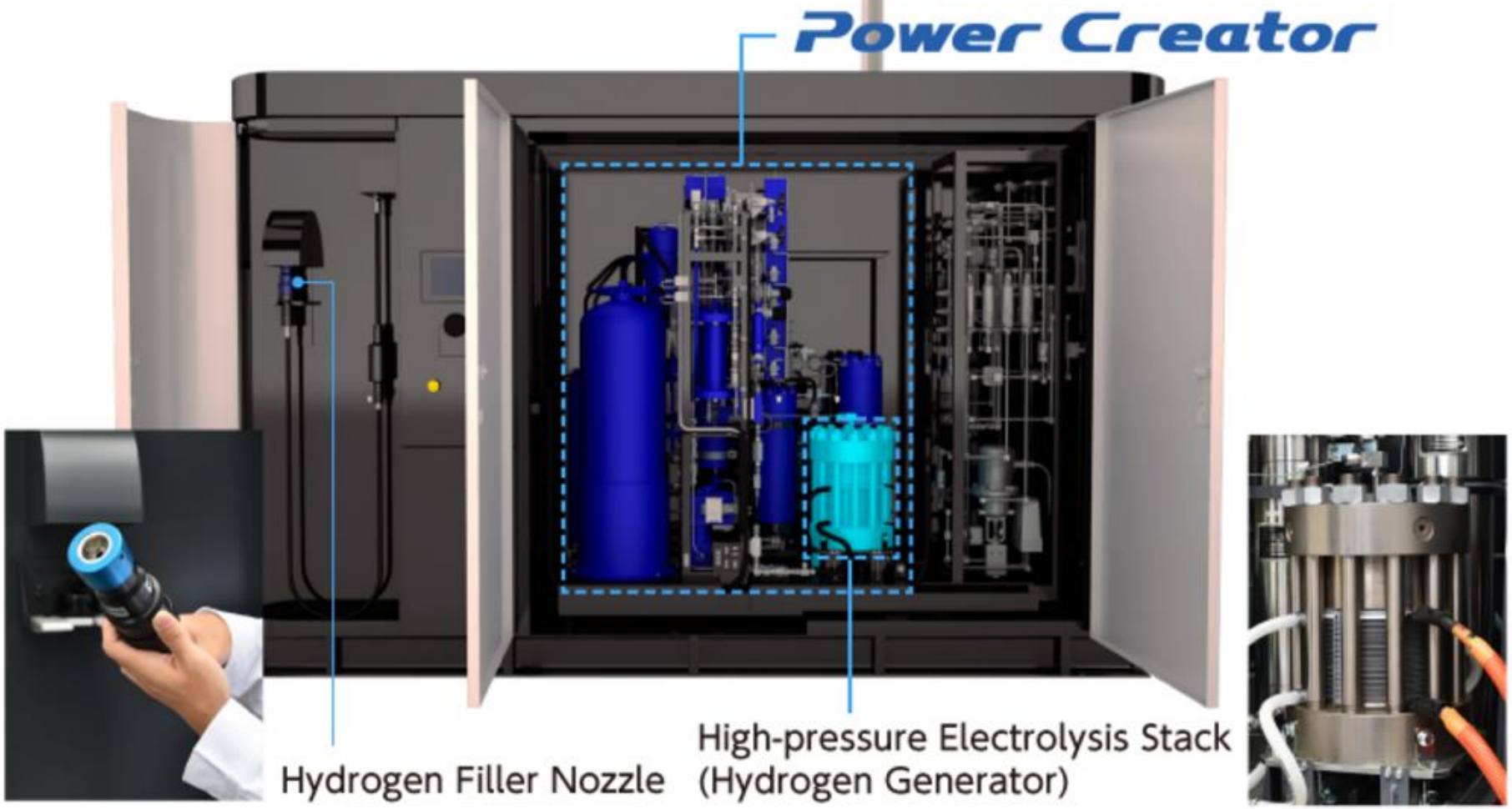

水素充填ノズルを操作する位置に雨除けの屋根などを設置


見事、日暮れ前に設置工事完了

Direct water electrolysis 70 MPa H_2 production

Smart Hydrogen Station (SHS) Structure

without a compressor

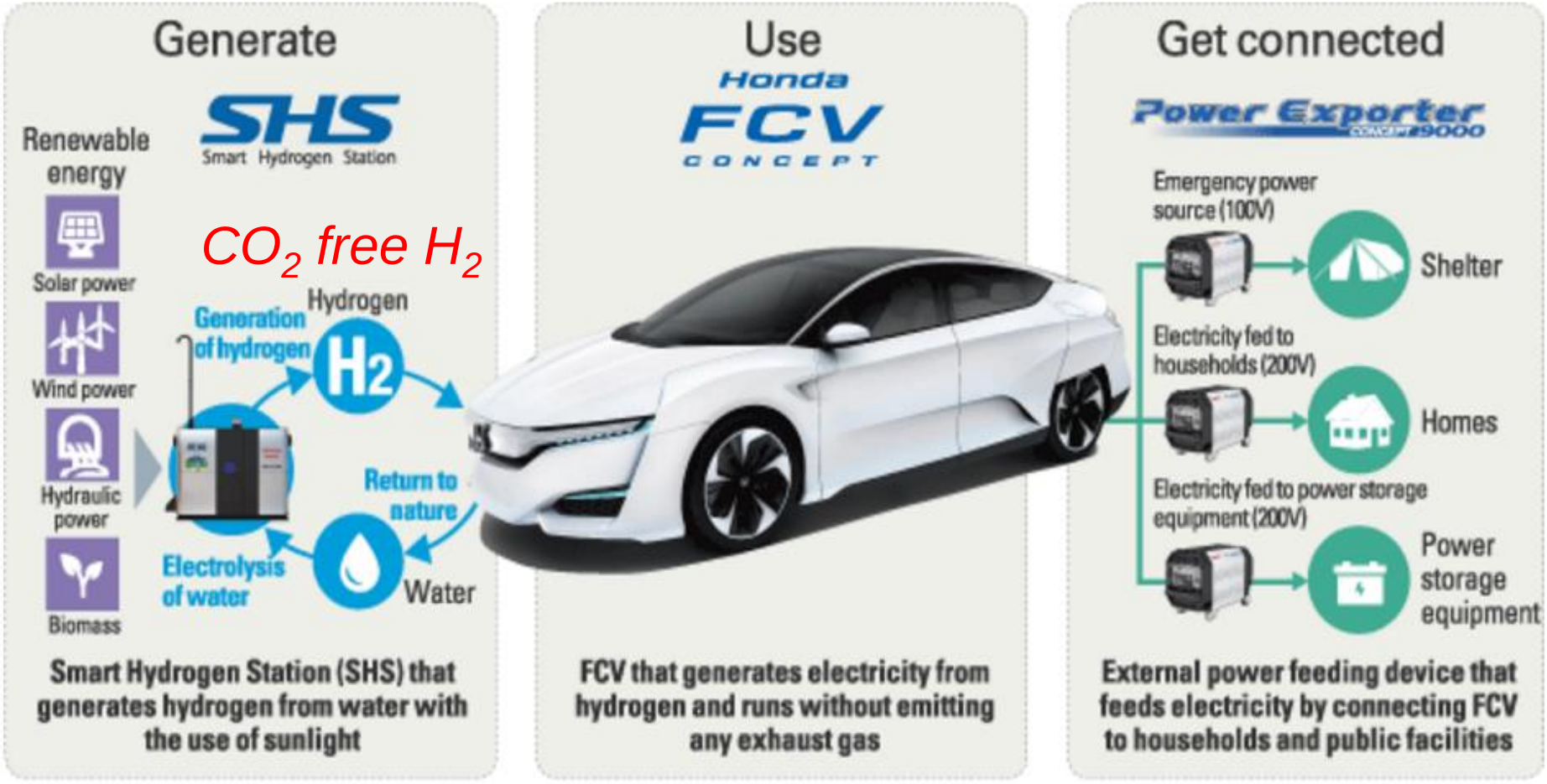


FCV acts as an electric generator in an emergency case

HONDA Power Exporter 9000

HONDA Concept :
Harmony with Humans and Society

Hydrogen energy society Honda envisions



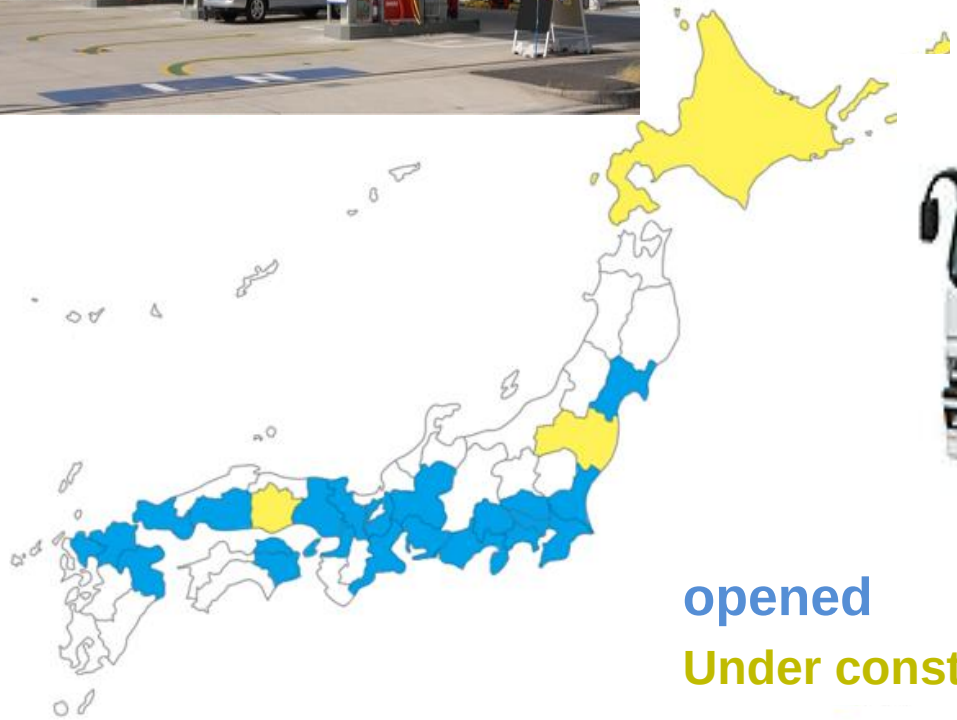
Smart Hydrogen Station (SHS) that generates hydrogen from water with the use of sunlight

FCV that generates electricity from hydrogen and runs without emitting any exhaust gas

External power feeding device that feeds electricity by connecting FCV to households and public facilities

Stationary & Mobile H_2 Filling Stations: 99 (Nov.2017)

Ca. 40,000 FCVs by 2020



opened

Under construction

Selling Price of H_2 in Japan

<Hydrogen Station>	<Gasoline station>
JPY110 to 150/Nm^3	**JPY140 to 170/L**
***)Future=> JPY30 to 40/Nm^3**	
JPY10 to 14 /km	**JPY14 to 17/km**

***)Driving range =10km**

***) Because the production price of H_2 is quite different by sources, the present selling price of H_2 has been determined based on actual driving performance of gasoline and FC vehicles.**