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2011 Tohoku Earthquake Damage by the Triple Disaster

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CONTENTS

Summery

- Disasters are social phenomena triggered by natural ones.
- 2011 Tohoku Earthquake brought triple disaster of Quake, Tsunami and Radiation to Japan and the world.
- Disaster of Fukushima #1 N-Plant is the Threat to Human beings.
- Direct & Monetary damage except “Fukushima” 200 - 325B$
- Intangible, indirect and non-monetary damages should be studied.
- Prevention and Mitigation of disasters should be implemented by integration of soft and hardware.
- Integrated Risk Management was introduced in “Draft Guideline for Water-related Disaster Risk Management” released in 2009 by WFEO-CDRM.
- The Guideline involves Part III Disaster Risk Management for Tsunamis:

There is no “Beyond Assumption” for Disaster Risk Management. We must prepare for the natural phenomena exceeding the assumption or design.

I. Basic Concept and Classification of Disasters

- WFEO Guideline -

Disasters are social phenomena induced by the nature and/or human beings as shown in “Fukushima”

Classification of Disasters

- Natural and Human induced
- Sudden Onset and Creeping Onset
- Direct and Indirect
- Tangible and Intangible
- Structural and Non-structural
- Monetary and Non-monetary
- Physical and Mental

Damages are not limited to Tangible, Direct & Monetary ones.

Countermeasures against disasters vary according to the characteristics of societies and the nature.

II. Natural Phenomena – 2011 Tohoku Earthquake

1. Earthquake

- M=9.0 Historical record in Japan, 4th in the world

  M=8.25 Meiji-Sannriku-Tsunami Earthquake 1896 Toll: 22,000
  M=7.9 Kanto Earthquake 1923 Toll: 105,000
  M=7.3 Hyogo-Nanbu Earthquake 1995 Toll: 6,400

- Seismic Intensity（JMA grade)

  Kurihara, Miyagi grade 7+ 2933Gal、
  Okuma, (Fukushima N-Plant) grade 6, 550 gal (126% of Design)
  Tokyo grade 5+

- Number of After-shocks (as of April 29)

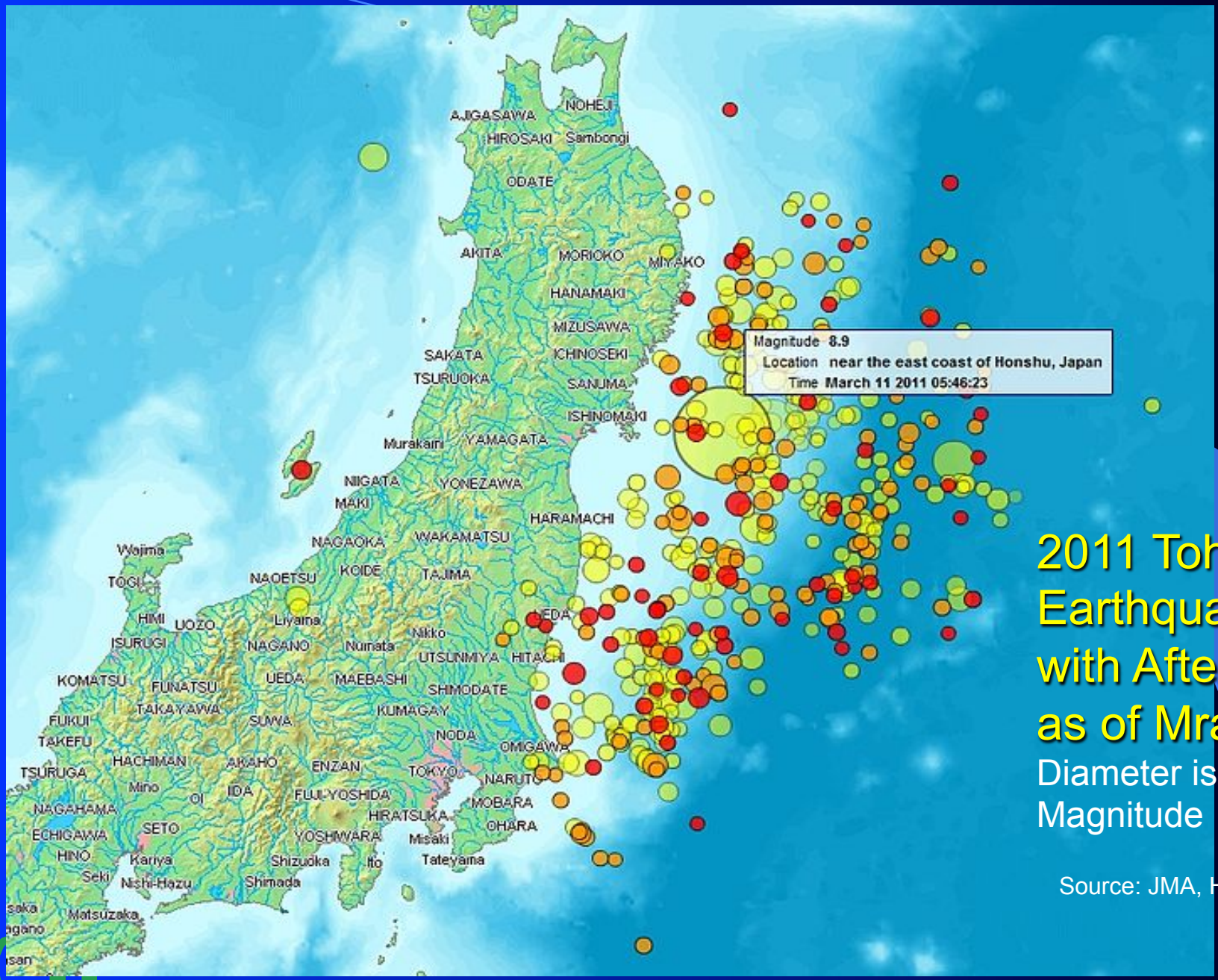
  above M7 5, Above M6 75, above M5 437

- Induced-Earthquakes

  Nagano, March 12 M6.7 Quake 6+
  Shizuoka, March 15 M 6.4, Quake 6+

- Crustal Movement

  Horizontal Displacement
  Ojika, Miyagi ESE 5.3m Ocean Bed ESE 50m
  Vertical Displacement
  Otsuchi, Miyagi －1.2m Ocean Bed, Miyagi ＋ 7m



2011 Tohoku Earthquake with Aftershocks as of Mrach 14

Diameter is scale of Magnitude

Source: JMA, H-J. Lucking

2. Tsunami　Wave Height

Near Epicenter

Ocean Bottom Pressure Gauge: Elevation +5m

GPS Wave Gauge: Wave Height 6.7m

Traces of Run-up Height, shore and inland （DL)

Observatories over 4m： scale-out

Omoe, Iwate 38.9m

Ryouri, Iwate 23.6m　(in 1896 38.2m)

Overtopping height at Tarou Tsunami Dyke, Iwate 15m

（Design T.P.10m=DL11.3m）

Fukushima N-Plant #1　14－15m（Design 5.7 m）

Ground Height +10.0m

Kona, Hawaii 3.7m, the Sea of Okhotsk, Russia 3.3m

Wave Velocity Kesennuma, Iwate 115km/h=32m/s

Onagawa, Miyagi 10m/s

Overtopped Dyke

Source: NHK

Devastated City

Source: NHK

III. General Damages Excl. Damage of "Fukushima"

1. Direct Damage

Casualties

Death 14,227 Missing 12,228 total 26,455 (April 23)

Direct Monetary Damage of Housings, Infrastructures:
200 - 325B$

Loss of Housing: 129,688

Inundated Area by Salt Water: 500㎢

Quick-Sand Area in Tokyo Bay area: 42㎢

Assets and Inventories of Factories, Farms & Fishery,

Assets of Households

Salt Contamination of Paddy Fields

2. Indirect Damage: Excl. Damage of "Fukushima"

Cost of Emergency Responses of Households, Firms, Farms/Fisheries, Gov't s

Evacuation

Evacuees: 270,000 March 23, 140,000 April 21

Rescue, Rehabilitation, Subsidiary or Compensation

Disruption of Business Activities

Drop of Household Income by Inundation of Firms

Drop of Sales and Production by Inundation, Destruction of Buildings & Inventories

Drop of Production due to No-Supply of Parts and Materials from Affected Suppliers

Damage of parts suppliers hampers auto industry in Japan and the world

Drop of Public & Utility Services

Drop of Sales due to Self Restraint of Consumers and Tourists

Drop of Sales due to Harmful Rumors

- 2. Indirect Damage continued-

Consequential Damage due to Traffic Disruption

325M Stranded Commuters in Tokyo in March 11.

Disruption of Business Operation of Surrounding Areas

Consequential Damage due to Lifeline Disruption

Consequential Damage due to Disruption of Business

Drop of Production of Non-Affected Factories due to lack of parts and interim products

Mental Damage

Caused by loss of relatives and assets, movement for evacuation, unemployment, lay-off

Risk Premium

Anxiety over the Possibility of Disaster

Country Risk on Disaster

3. Drop of Japanese Economy as Indirect Damages

Factory output: - 15.3% from February
Household spending: - 8.5%
Retail sales: - 14.7%
Construction of housing: - 2.4%
Drop of GDP Growth: 0.6 point drop from +1.4%
Japanese Auto Industry production: 57.5% of a year earlier
Japanese Auto Firms abroad be hampered production
Retailers-Department Stores - 14.7% from a year earlier
Self Restraint
Tourism Passenger Domestic Air Lines - 20%
Dive of Customers of Restaurant, Golf links
Harmful Rumors mainly on “Fukushima”
Foreign Tourists: - 50%

IV. “Fukushima” – Accident of Nuclear Plants

1. Electric Power of Japan

Total Output 956Bkwh （TEPCO 194）
Capacity 217Mkw （TEPCO 63-64）
Nuclear 29% 55Reactors Capacity 49Mkw
（TEPCO 27% 17）
Fossil Fuel 61% （TEPCO 59%）
Water 8% （TEPCO 13%）
New Energy 1% （TEPCO 1%）

Demand/Supply of TEPCO
Spring D. 41Mkw
Summer D. 60Mkw (Peak 64)
Supply 64Mkw
Nuclear Plant 17 Fukushima#1,#2 9 Kariwa 8
Sales 194Mkwh

Damage of Fukushima #1 N-Plant

Before March 11

After Mach 12, Hydrogen Explosion

2. Damage of TEPCO

Tsunami and Quake made 8 power plants drop 29Mkw.

Fukushima #1 N-Plant was heavily damaged.

4 N-Plants was slightly affected but stopped operation

TEPCO Fukushima #2

Japan Atomic Power Co. Tokai

Tohoku EPCO Onagawa and Higashidori

Imbalance of S/D

Spring: Supply 31 Mkw Demand 41 Imbalance 10

Summer: S.31/D. 60 Imbalance 29 or 50% of D.

Imbalance will cause General Black-Out in Tokyo Area

Urgent Measures against General Black-Out

Saving in households

Close and saving of factories 25% down of D.

Purchase from independent power supplier 1.5Mkw

Urgent Construction, Operation rate of existing thermal plant,
Pumping power plant 10Mkw

Rationing by Scheduled Black-Out

3. Damage by “Fukushima”

1) Radiation

Fukushima

Around Fukushima N-Plant: March 16 over 20mSv

21 workers exposed to radiation of 100mSv but without injury

Off-shore sea bottom soil: Cs137 1,400Bq/kg x100-1,000 of usual level

Tokyo

Before “Fukushima”: 10mBq/㎡/Month

After “Fukushima”: Cs137 April 11 170,000mBq, April 12 4,000mBq

Nuclear Bomb Tests June, 1963 550,000mBq

After Chernobyl 1986 110,000mBq

Diseases by these radiation were not recognized Epidemiologically

Natural Background Radiation 2.4mSievert

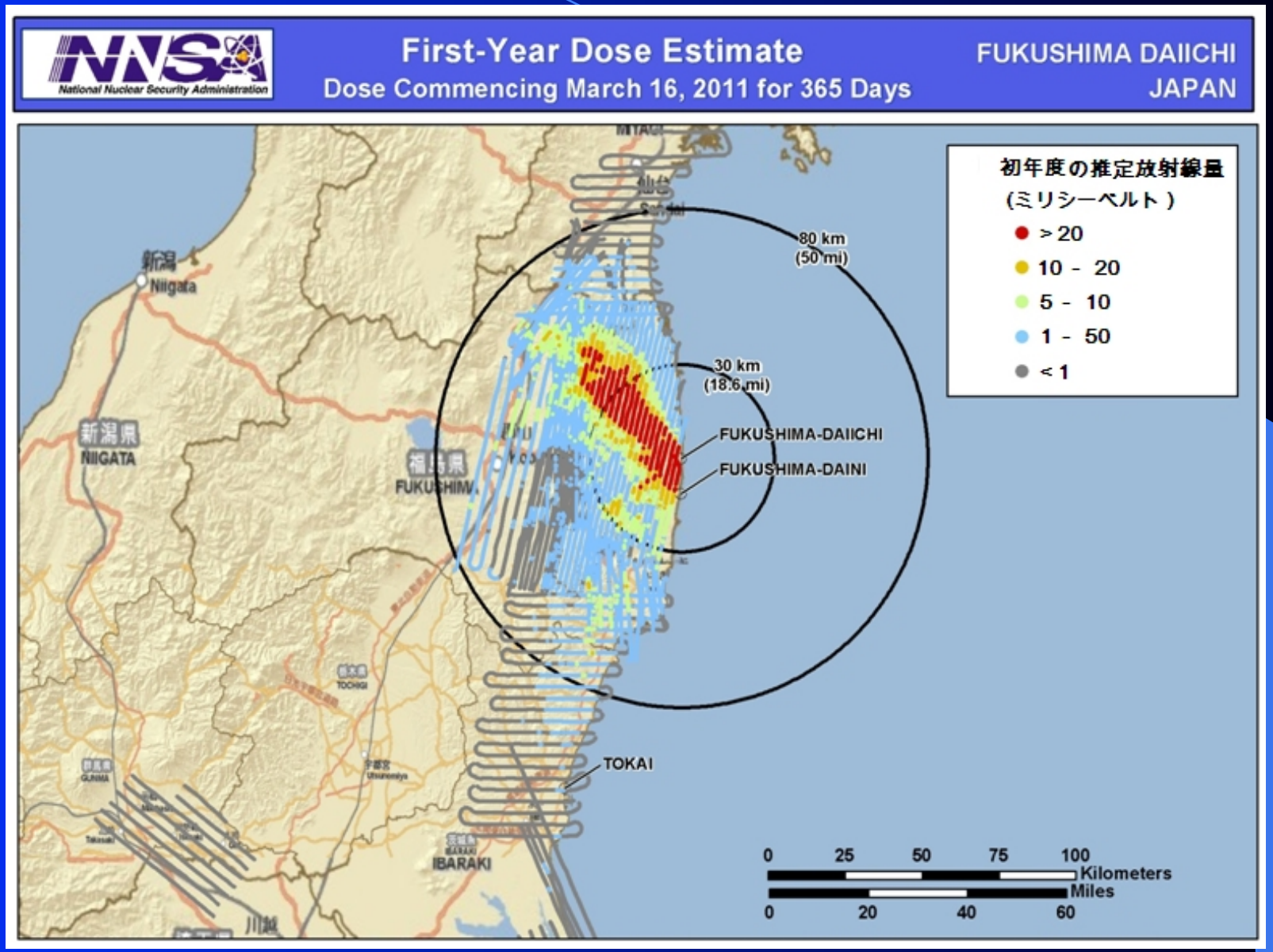
Tokyo Radiation 0.069microSv/h April 29, 2011

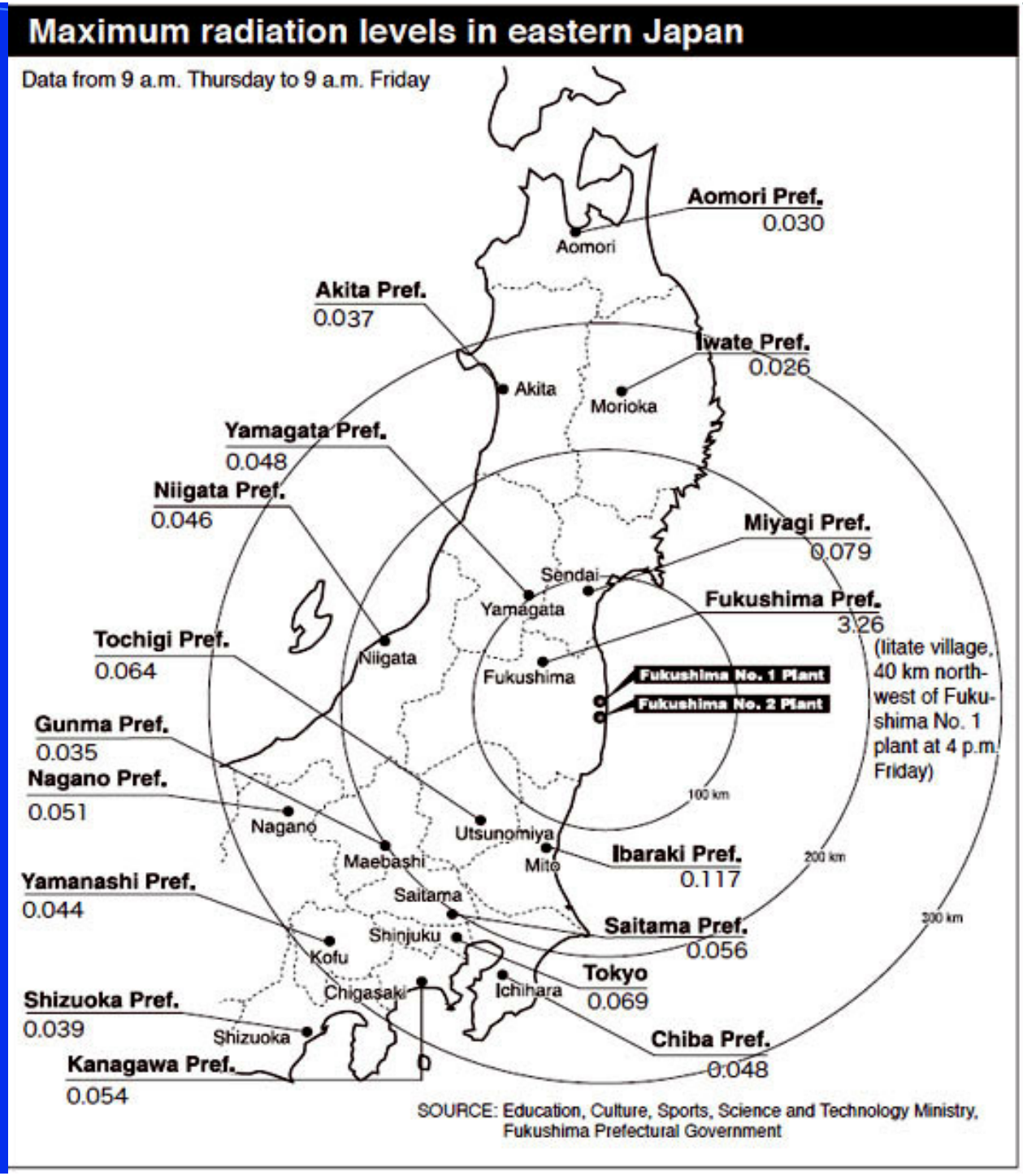
Tokyo-New York Round Flight: 0.1 – 0.2mSv

Annual dose limit for nuclear workers: 50mSv

Radiation accumulated 1 year around “Fukushima”

source: National Nuclear Security Administration Unit: mSv





Radiation level in

East Japan

April 29

Unit: microSv/h

source Japan Times

2) Direct Damage by “Fukushima” Radiation

TEPCO N-Plant: Housings, Machineries

Surrounding Factories, Farms, Fisheries: Housings, Assets, Inventories

Abandoned farm products and lands contaminated by radiation

Mercy-kill of live-stocks and pets:

Cows 3,000, Poultry 600,000

Abandoned housings and assets: Households 37,000

3) Indirect Damage by “Fukushima” Radiation

Evacuation

No-Entry Zone: 20km from N-Plant, 9Municipalities

Households 27,000 Residents 78,000

Planned Evacuation Zone: 20-30km & over 20mSv zone, 5Municipalities

Households 10,000 Residents 15,000

Cost of Emergency Responses

Households, Factories, Farms/Fisheries, Gov’ts

Emergent Operation to Stabilize Reactors: Continuing

by TEPCO, METI, Local Gov’ts, Municipalities

Disruption of Business Activities

Power failure may hamper the business.

4.1M Households and Firms faced power cut-off.

TEPCO Output Drop 17.6% from a year earlier to 5.49 Bkwh

TEPCO Stock Loss

12 Insurances and Banks of 400 B\, 4.5 B$

Stocks of power firms drop record lowest 2011

Harmful and Untrue Rumors

50 countries impose excessive regulation,

slower clearance to Japanese products. USA, China, Korea, Egypt etc.

Drop of sales of farm products

Foreign tourists 350,000, 50% decrease from a year earlier

Apology of International Herald Tribune for the cartoon:

The Apple of “Snow White”, was it imported from Japan?

Refusal to rent art works to Japanese museums and reluctance of insurance companies.

Cost of Radiation Check

4) Indirect Damage of “Fukushima” possibly compensated by TEPCO and/or Gov’t

Nuclear Accident Indemnity Dispute Council, Gov’t

① Cost of Evacuation: Travel, accommodation
② Drop of Sales: Sales, Commodity Relocation and Abandonment
③ Salary: Disruption of firms, Lay-off
④ Asset: Loss of value, Cleaning of radiation
⑤ Cost of radiation check of residents
⑥ Cost of radiation check of commodities and land
⑦ Injury: Medical cost of N-P workers, illness of Evacuees
⑧ Mental Damage: Mental hurt without physical injury
⑨ Drop of shipping by self-restraint of farmers and fishermen
⑩ Damage by harmful rumors -under study-

Excluding the national and/or International Indirect damage

Indemnity Estimation: 63B$ by the Nikkei, April 26
50B$ by the Asahi, May 3

TEPCO: Capital=7.5B$ Annual Turn-over=53B$

V. Conclusion: Integrated Disaster Risk Management

Investigation of Natural Phenomena & Damages
Direct & Indirect, Emergent Action Deployed
Analysis of Damages and Effects of Counter Measures
Emergency Rescue, Temporary Restoration
Financial Aid to Residents, Factories, Farms/Fisheries, Retailers
Permanent Reconstruction with

Integrated Disaster Risk Management Plan
against All Natural Phenomena "Beyond Assumption"
Integration of Hard and Soft Measures with Emergency Plan
National Reconstruction Plan, Energy Development Plan
in accordance with Low Carbon Programme, Business and Industrial Reconstruction Plan,
Urgent Budget Allocation

- **Japan had overcome**

- 1923 Kanto Earthquake with death toll 105,000
- 1945 Loss of the World War II which claimed 800,000 lives of civilians and devastated cities

- **We shall stand up again!**

Thank you !

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