Regulatory Capture
The nuclear disaster at Fukushima Daiichi and eruption of Vesuvius

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Before 11 March 2011

Nuclear power plant: 6 reactors, each one containing 2000 tons of fuel.
Protective barrier 4 m high on the side of the ocean protects the plant.

Earthquake with the epicenter of magnitude 9 on the Richter scale on 11 March 2011 at 2:46 pm at the depth of 30 km caused by subduction of the northern pacific plate under the euroasiatic plate.

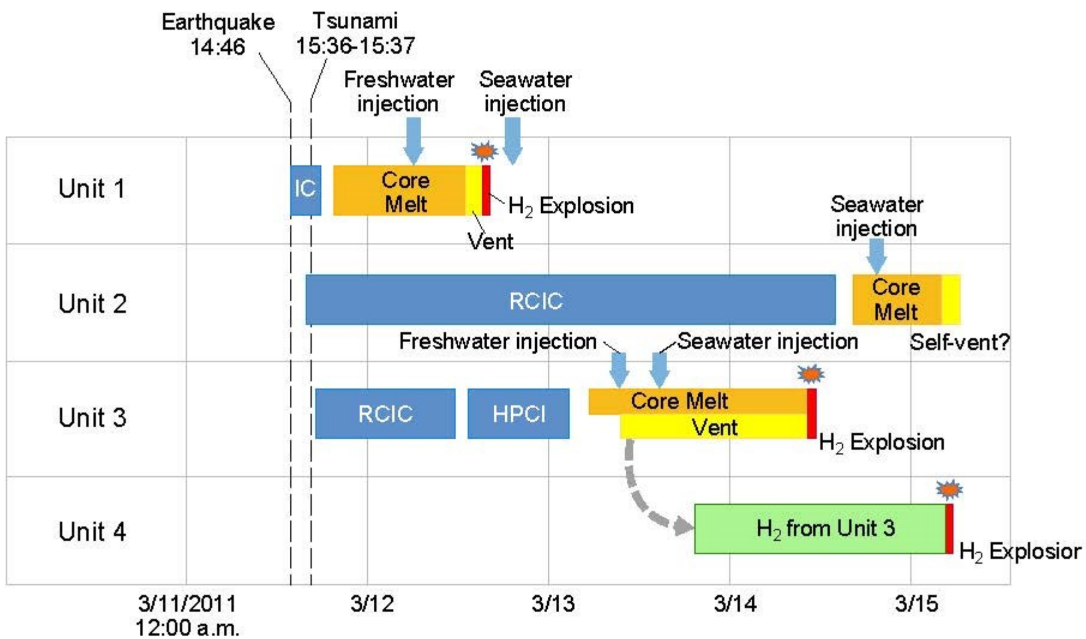
- The earthquake produced a tsunami 12 m high that over-flowed the protective barrier 5 m high of the power plant.
- 1, 2, and 3 nuclear reactors were in operation.
- Reactors 4,5,6 were in maintenance.

Tsunami hitting the protective barrier of the nuclear power plant.

Are there precedences of large earthquakes and tsunamis in the area of Fukushima Daiichi plant?

- YES, but these occur with low probabilities.
- 9 seismic events with magnitudes > 7 from 1973.
- The Japanese coast was exposed in the past with tsunami 30 m high.
- Risk was evaluated with maximum probabilities of earthquakes and tsunamis and not on maximum expected earthquakes and tsunamis that have much smaller probabilities. This is typical in constructions all over the world.

Sequence of events that led to the destruction of nuclear power plant.



RCIC = Reactor Core Isolation Cooling

HPCI = High-Pressure Coolant Injection

IC = Isolation Condenser

- Cooling system active
- Containment venting
- Core melting
- Hydrogen backflow into unit
- Hydrogen explosion

Length of bar indicates duration

1 curie = 37,000,000,000 disintegrations/s

Cesium-137 = 88 curie/g

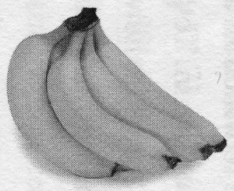
Strontium-90 = 140 curie/g

Potassium-40 = 140/1,000,000 curie/g (banana)

1 g cesium-137 distributed on 1 km^2 will produce an exclusion area

150 curie cesium-137 = 1,700,000 g cesium-137

Naturally occurring radionuclide:



Potassium-40 (K-40) found in bananas

Radioactive Properties of Potassium-40							
Isotope	Half-Life *(yr)*	Natural Abundance *(%)*	Specific Activity *(Ci/g)*	Decay Mode	Radiation Energy *(MeV)*		
					Alpha (α)	Beta (β)	Gamma (γ)
K-40	1.3 billion	0.012	0.0000071	β, EC	–	0.52	0.16

Specific Activity = Radioactivity of K-40

0.0000071 Curies per gram (Ci/g) = seventy-one ten-millionths Curies per gram

Radioactive properties table courtesy of Argonne National Laboratories

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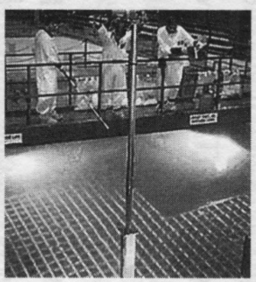
Man-made Radionuclides: Fission Products

Specific Activity = Radioactivity

Cesium-137 (CS-137) = 88 curies per gram



Spent-fuel pool image from U.S. Dept. of Energy

Strontium-90 (Sr-90) = 140 Curies per gram

Radioactive Properties of Key Cesium Isotopes and an Associated Radionuclide

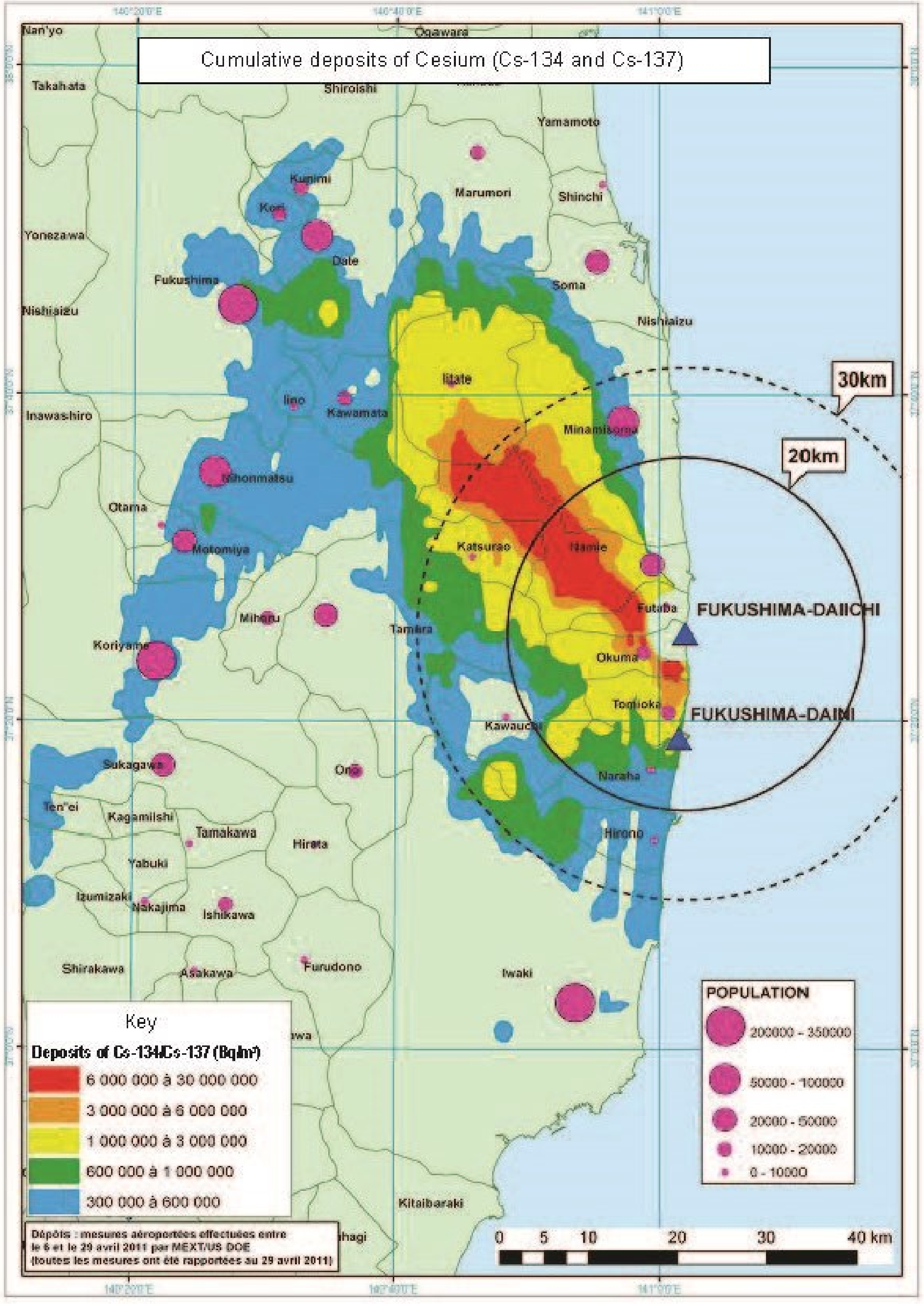
Isotope	Half-Life	Specific Activity *(Ci/g)*	Decay Mode	Radiation Energy *(MeV)*		
				Alpha *(α)*	Beta *(β)*	Gamma *(γ)*
Cs-134	2.1 yr	1,300	β	–	0.16	1.6
Cs-135	2.3 million yr	0.0012	β	–	0.067	–
Cs-137	30 yr		β	–	0.19	–

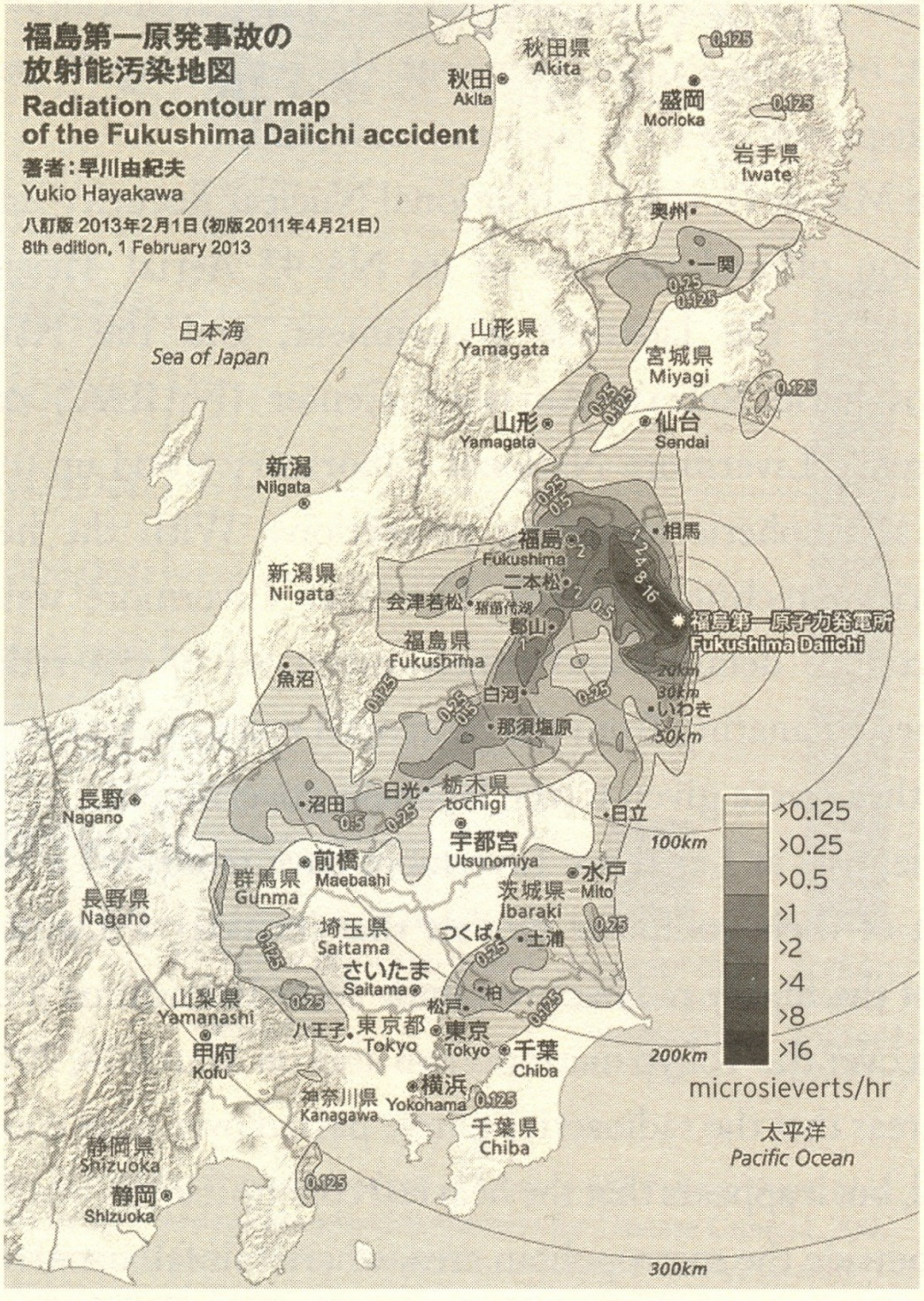
Radioactive Properties of the Key Strontium Isotope and an Associated Radionuclide

Isotope	Half-Life	Specific Activity *(Ci/g)*	Decay Mode	Radiation Energy *(MeV)*		
				Alpha *(α)*	Beta *(β)*	Gamma *(γ)*
Sr-90	29 yr	140	β	–	0.20	–

Radioactive properties table courtesy of Argonne National Laboratories

Distribution of radiation





- In several days the cores of reactors 1, 2 e 3 melted through 15 cm-thick steel.
- Emissions of radioactive noble elements (argon, xenon, krypton) of reactors were 3 times higher than in the disaster at Chernobyl in Ukraine.
- 30,000 km^2 (13%) of Japanese territory was polluted.
- 80% of radioactivity escaped from Japan.
- 14,500 km^2 of the area around Fukushima Daiici exceeded the limit of acceptable radiation.
- 650 km^2 was declared the exclusion zone.

- For TEPCO (Tokyo Electric Power Company) that manages the nuclear reactors the highest risk was the closure of the reactors because of strict regulations.
- TEPCO managed to reduce national regulations for the operations of reactors through the lobbies.
- The Japanese government considered an evacuation but did not give an evacuation order.
- More than 200,000 people fled in the direction of the dispersion of the radioactive cloud, even though the monitoring instruments signaled that this is the wrong direction for the evacuation.
- Some 100,000 people remain today dispersed.

- The Japanese government and TEPCO negated for 2 months that the reactors 1, 2 e 3 were melting.
- TEPCO continued announcing that it “tries to prevent melting of reactors”, without being contradicted by the Japanese government.
- TEPCO decided when and what information was released to the public.
- The Japanese nuclear establishment is a clear example of **regulatory capture** – a form of failure that occurs when a government regulatory agency, created to act in the public interest, instead advances the commercial or political concerns of special interest groups that dominate the industry or sector it is charged with regulating.

- Regulatory capture is one form of the failure of a state and is the principal reason for the Fukushima Daiichi disaster.
- This capture occurs because the groups or individuals with large interests from political decisions or regulations manage to obtain the results that they want.
- The risk of regulatory capture suggests that the regulatory agencies should be protected from external influences and if not should not be created.
- A "captured" regulatory agency that serves the interests of the subjects that it regulates with the power of the government is worse than having no regulations at all.

Further elements of the disaster Fukushima Daiichi

- Concentration of large quantities of dangerous materials in one place (6 reactors)
- Fukushima Daiichi in an example of a complex interactive system where a small part of this system often produces a destabilization of the entire system (locating electrical emergency generators underground)

  Complex emergency management plans, large industrial installations or infrastructure (electrical power stations, hospitals) situated in dangerous areas.
- Fukushima Daiichi operators (TEPCO) knew that large earthquakes and tsunamis occurred in the area, but ignored this risk possibility in favor of more probable risks (to save on the construction cost)

Common elements between the risk managements of the nuclear installation at Fukushima Daiichi and Vesuvius

Fukushima-Daiici	Vesuvius
Concentration of large quantity of dangerous materials in one place	Concentration of 1,000,000 people in a dangerous area.
Regulatory capture.	Capture by a politicized scientific community – regulatory group.
Evacuation plan not followed.	Will the evacuation plan for Vesuvius be followed in 2, 20 or 200 years into the future?
Complexity of interactive systems.	Complexity of massive evacuation plan (diaspora) (evacuation in 2-3 days of 1,000,000 people when the territory shakes, displacement of people who do not want to abandon their homes, protection of evacuated areas from looters, transportation of angry population across the areas non evacuated, dispersion of people in foreign lands, …)
Emergency systems (pumps, electrical generators) very vulnerable.	Constructions of emergency systems (hospitals, services systems) in vulnerable areas, non-effective evacuation routes, non-dependable transportation systems, protections of evacuated areas, acceptance of evacuees in different socio-political and cultural areas, culture destruction.
Risk not based on maximum earthquake and tsunami evens.	Risk not based on maximum possible volcanic events.

Why in a developed world the disasters are inevitable?

- A disaster arises from the social order.
- The culture permits and encourages the practices that contribute to the risk.
- The economic and political forces contribute enormously to the risk.
- The forces that maintain status quo and allow for the risk to proliferate are resilient.
- Risk and power are connected.
- We cannot expect a reduction of risk if we can’t make the scientists and government representatives responsible.

CONCLUSION

The current practices for avoiding disasters are not sustainable and the sustainability and the security will never be achieved without a radial rethinking of cultural practices, social dispositions, and institutional practices