

Promotion of Disaster Reduction Policies based on Evidence and Lessons Learnt - The Japanese Experience -

17 April 2023



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Ranking of Earthquakes 20-21st Century

Strong Earthquakes

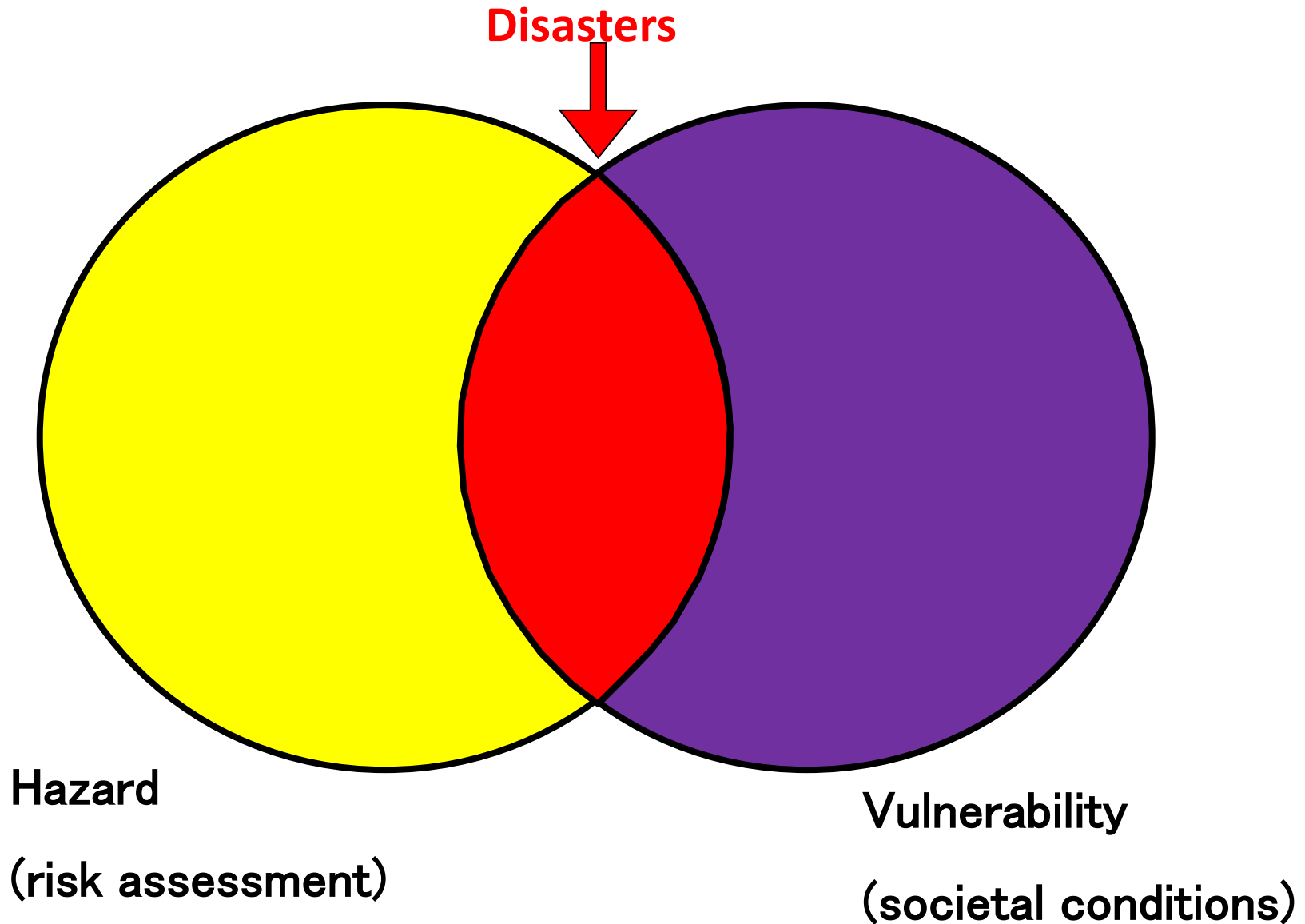
Year	Place	Magnitude
1960	Chile	9.5
1964	Alaska	9.2
2004	Indonesia Sumatra	9.1
2011	East Japan	9.0
1952	Kamchatka	9.0
2010	Chile	8.8
1906	Ecuador	8.8
1965	Alaska Aleutian Islands	8.7
2005	Indonesia Sumatra	8.6
1950	Tibet, Assam	8.6
1957	Alaska Aleutian Islands	8.6

Deadly Earthquakes

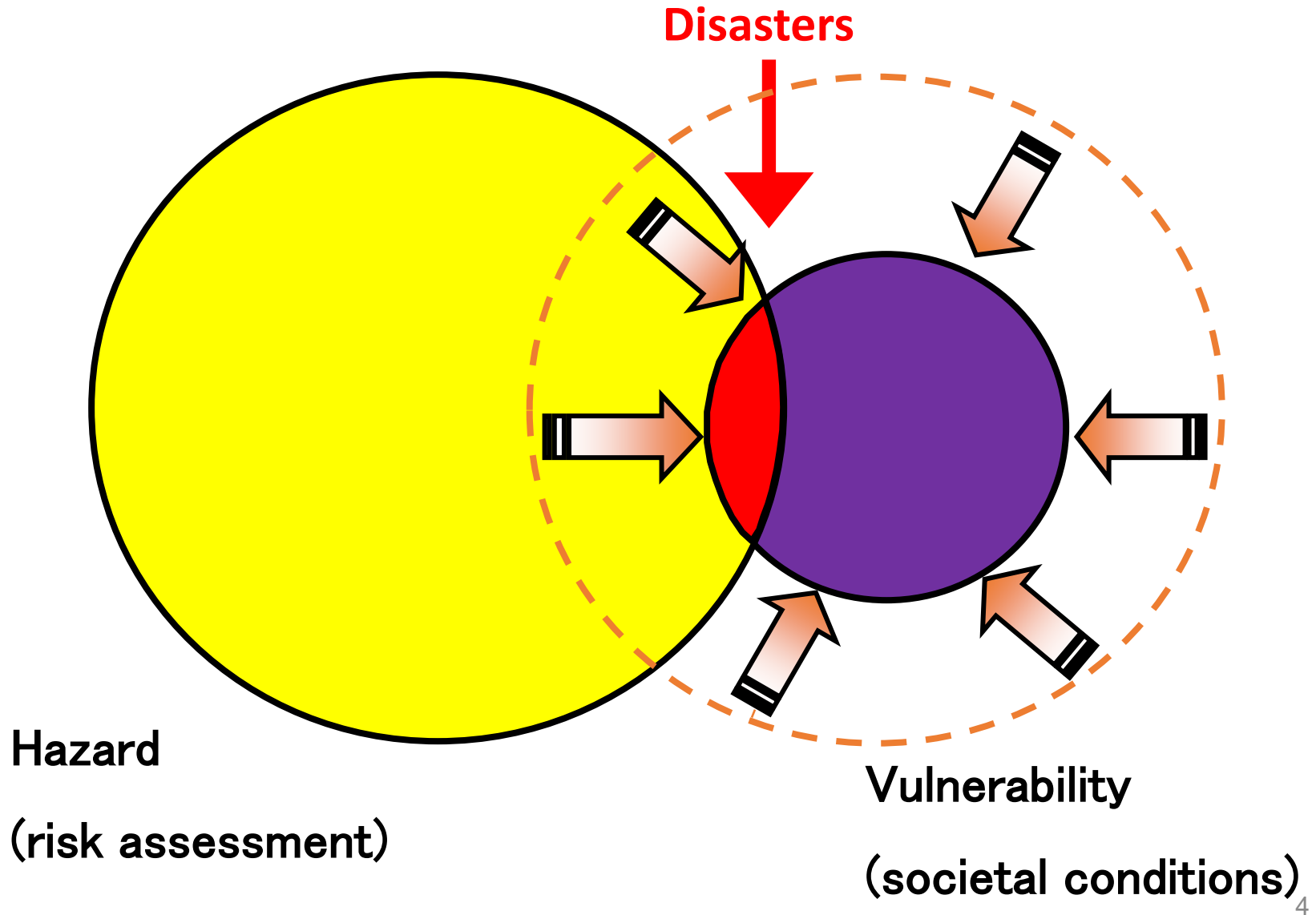
Year	Place	Casualties
1976	China Tangshan	242800
1920	China Ningxia	235502
2004	Indonesia Sumatra	227898
2010	Haiti	222500
1948	Turkmenistan	110000
1923	Japan Kanto	105000
2008	China Sichuan	87587
2005	Pakistan, Afghanistan	86000
1908	Italy Sicily	82000
1927	China Gansu	80000
1970	Peru	66794
	.	
	.	
2011	East Japan	18423

Casualty figures of East Japan EQ is from National Police Agency report

Hazards Confronting Vulnerable Communities Cause Disasters



Less Disasters



How?

Four Phases of Disaster Reduction

Pre-Disaster

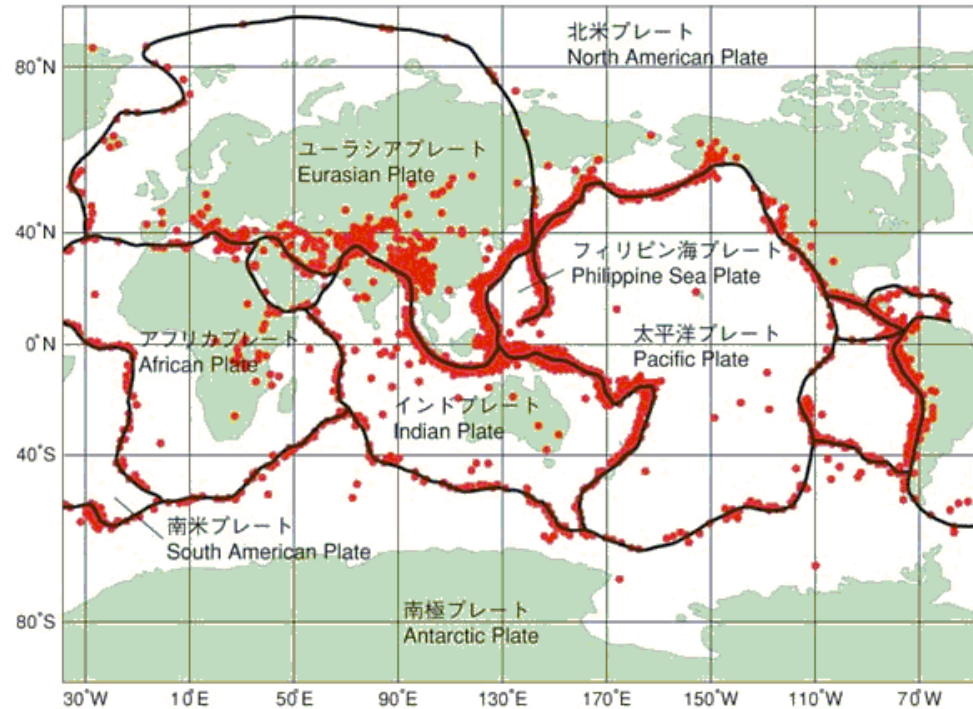
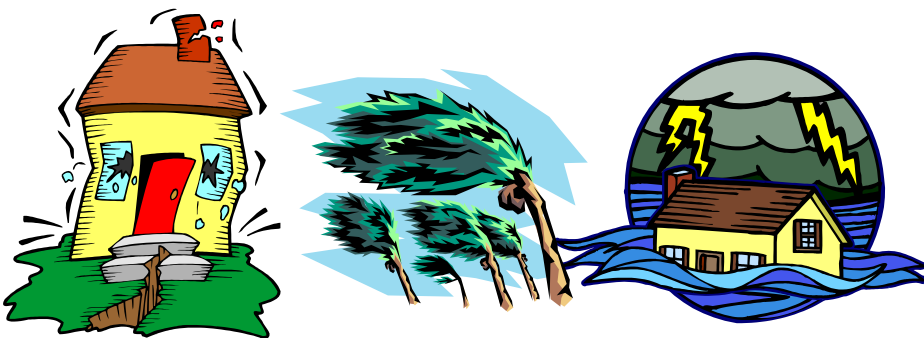
- Prevention & Mitigation
- Preparedness

Post-Disaster

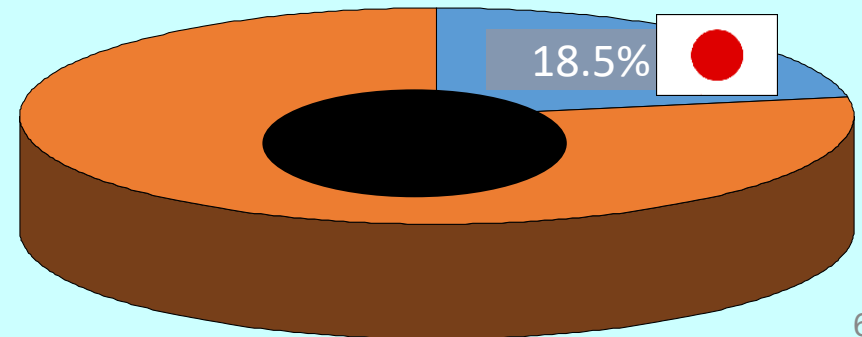
- Response
- Recovery & Reconstruction(BBB)

Mother Nature is not Gentle in Japan !

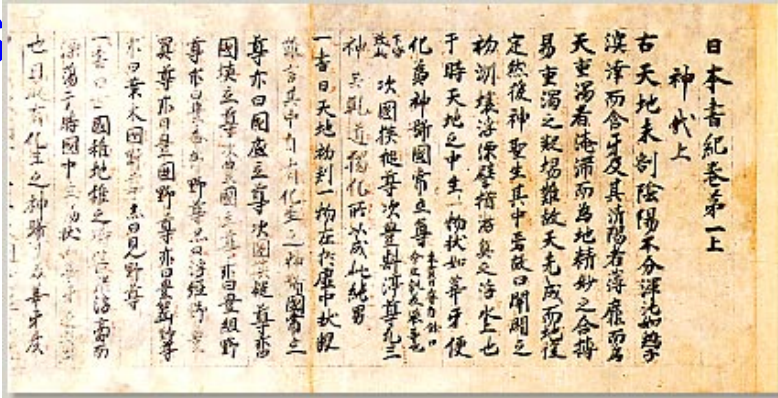
- Earthquakes
- Tsunamis
- Volcanic Eruptions
- Typhoons
(July – October)
- Heavy Monsoon Rains
(May – July)
- Floods
- Landslides
- Snow Avalanches



Number of earthquakes with magnitude of 6.0 or larger (2003-2013) Japan's Unfair Share



Japan's long tradition of coping with natural disasters



- 416A.D. August, Yamato-Kochi Earthquake

The first written record of Earthquake in Japan within “Nihonshoki” the first official history book of Japan, edited in 8th century.

- 684A.D. November, Hakuho-Nankai Tonankai Earthquake (Estimate Magnitude: 8.2-3) & Tsunami

The first written record of Earthquake Tsunami in Japan within “Nihonshoki”.

- Most dreadful things historically in Japan for children

1. Earthquakes
2. Lightning/Thunder
3. Fire
4. father

Jishin

Kaminari

Kaji

Oyaji

Not anymore

7-8th century

The Most Respected Buddhist Priest was the Best Civil Engineer



行基の熱意と、「菩薩さま」として集まってきた人々の力によって、大雨による洪水を防ぎ、かんがい用水をためる多目的ダムとなったこの昆陽池は、1200年後のいまも、上水用の貯水池として用いられています。

- 菩薩 真の悟りを求めながら人々を助け、修行にはげむ聖者。
- 現池は当時の1/3の貯水量。15万立方m。



GYOKI the High Priest & his fellow monks built dams for flood control and irrigation.



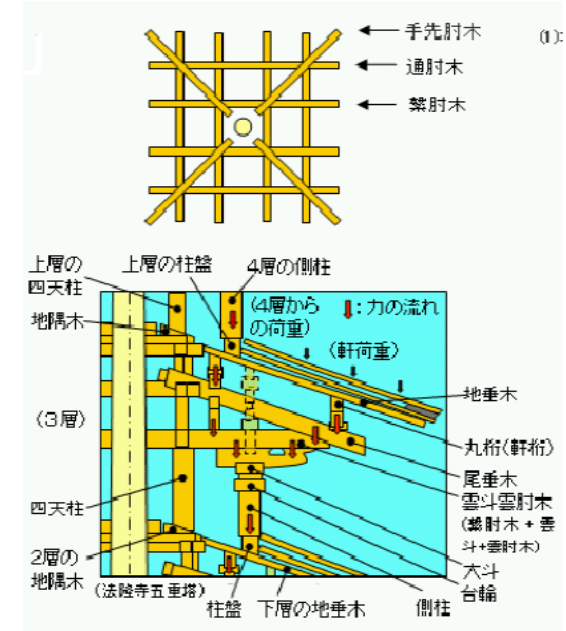
Pagoda of Horyu-ji Temple built 680A.D.

The Oldest Wooden “High-Rise” Building in Japan withstood numerous Earthquakes over the Centuries

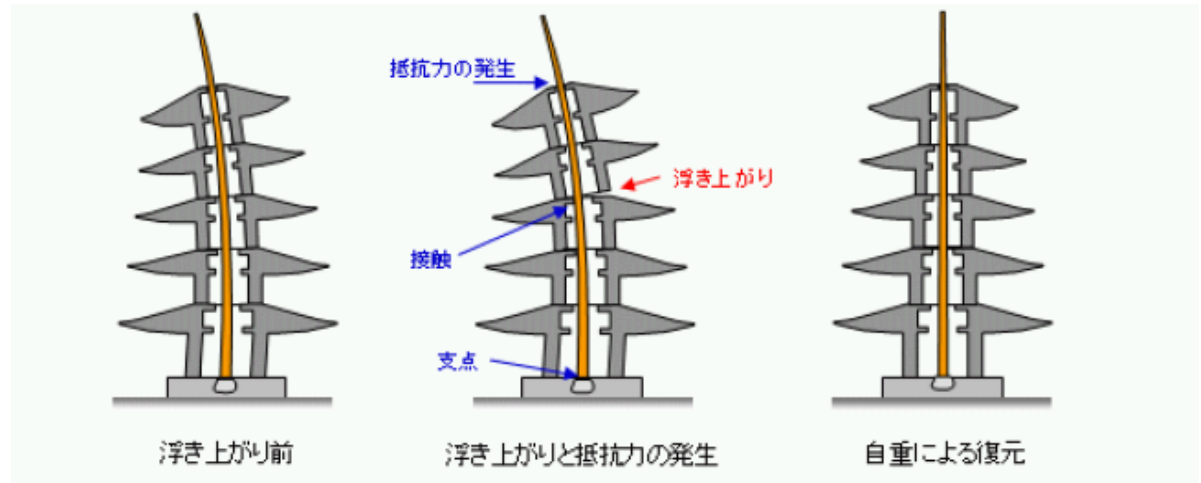


5 layered, 32m high

Combination of semi-flexible timberwork joints and a central wooden pillar disperses and absorbs earthquake shocks



層の構造の詳細

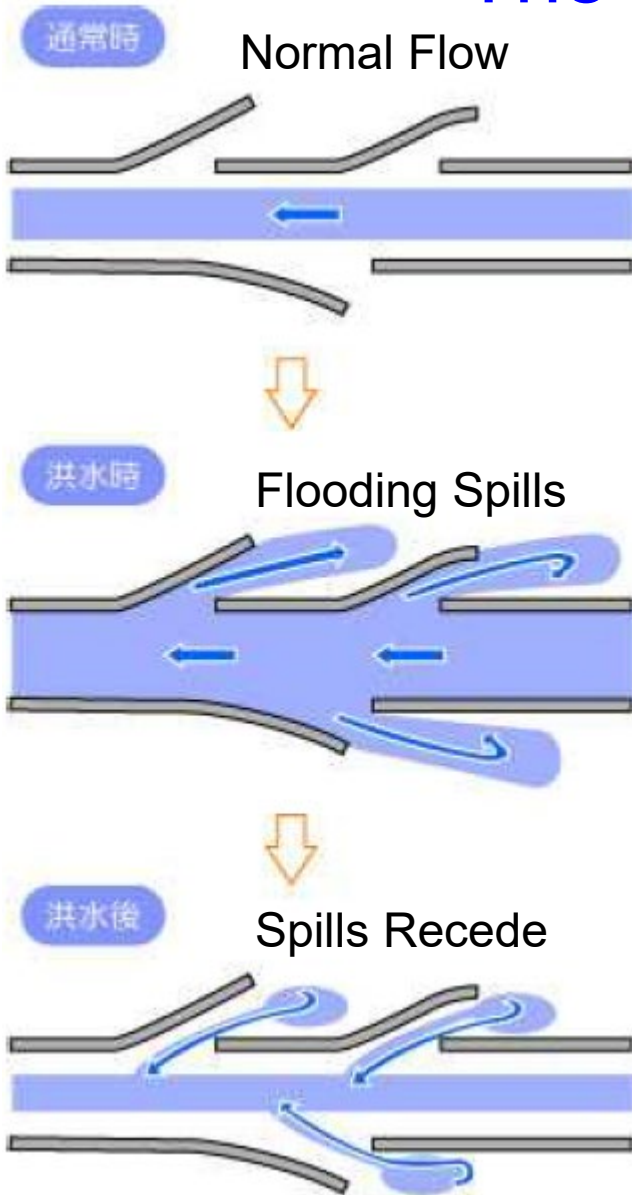


16th century

The Lord Who Controls the River is The Ruler of the Land



Innovative Civil Engineering Flood Control Techniques by Warlord Takeda Shingen



SHINGEN Tsutsumi (Grouped Echelon Embankments) is still valid for minimizing flood damage in modern Japan

Traditional “UKIYOE” drawing after 1855 October Ansei-Edo Earthquake



Edo (Old name of Tokyo) citizens beating the legendary Catfish Monster which was believed to cause earthquake

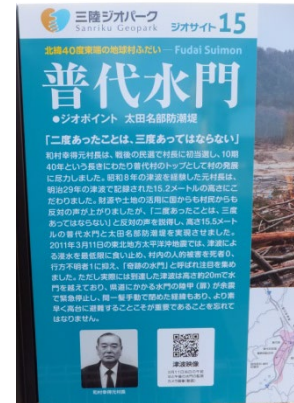
Modern Japan is still full of Tragedies & Lessons Learnt



1896 Meiji-Sanriku
Tsunami killed 22,000



The great watergate
of Fudai was
constructed in 1984
by village mayor
Kotoku Wamura,
saved the lives of
villagers in 2011.

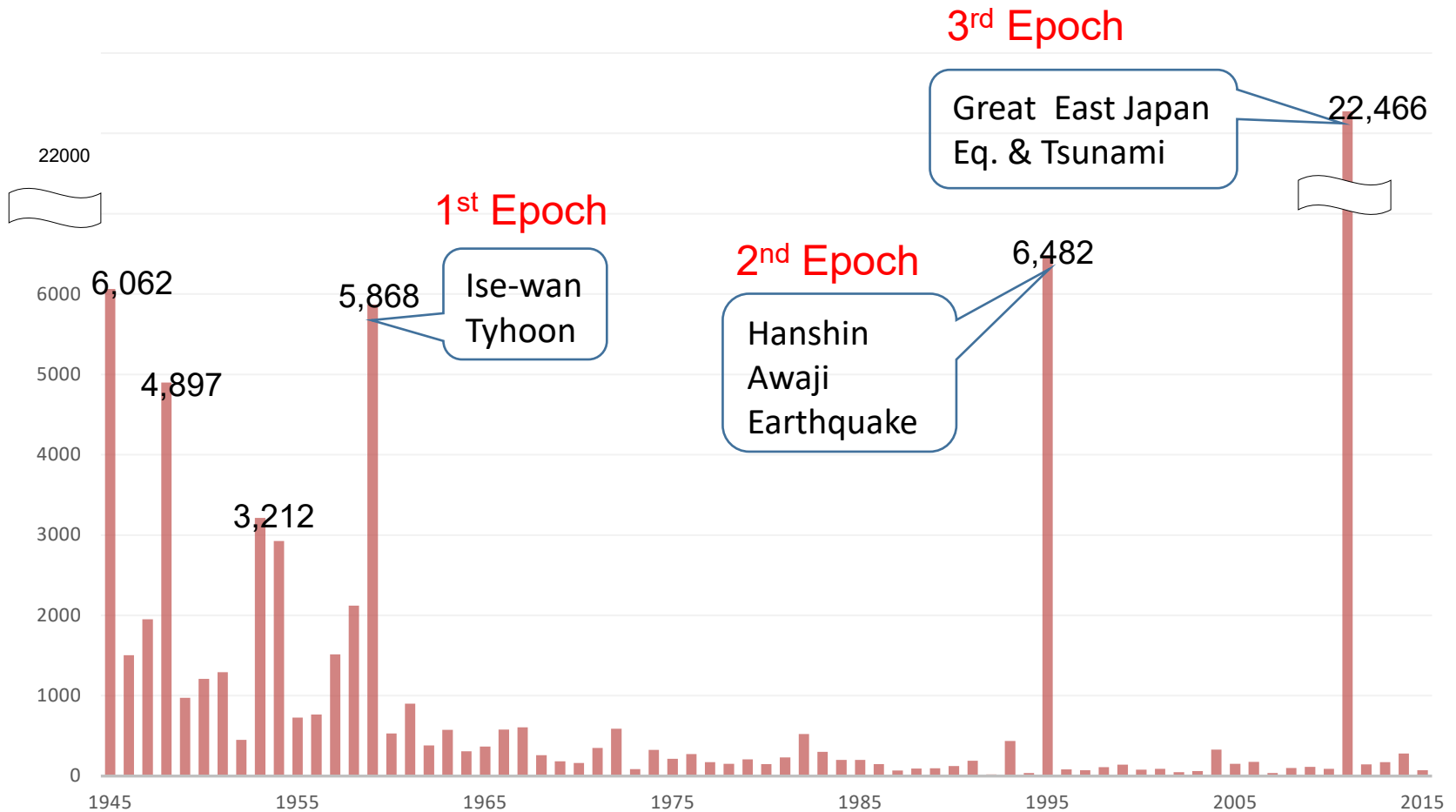


1923 Great Kanto Earthquake
destroyed Tokyo and killed 105,000



The reconstruction plan of the imperial capital by
Shinpei Goto laid the basis of modern Tokyo master
city plan.

Statistics on Casualties by Natural Disasters in Japan 1945-2015

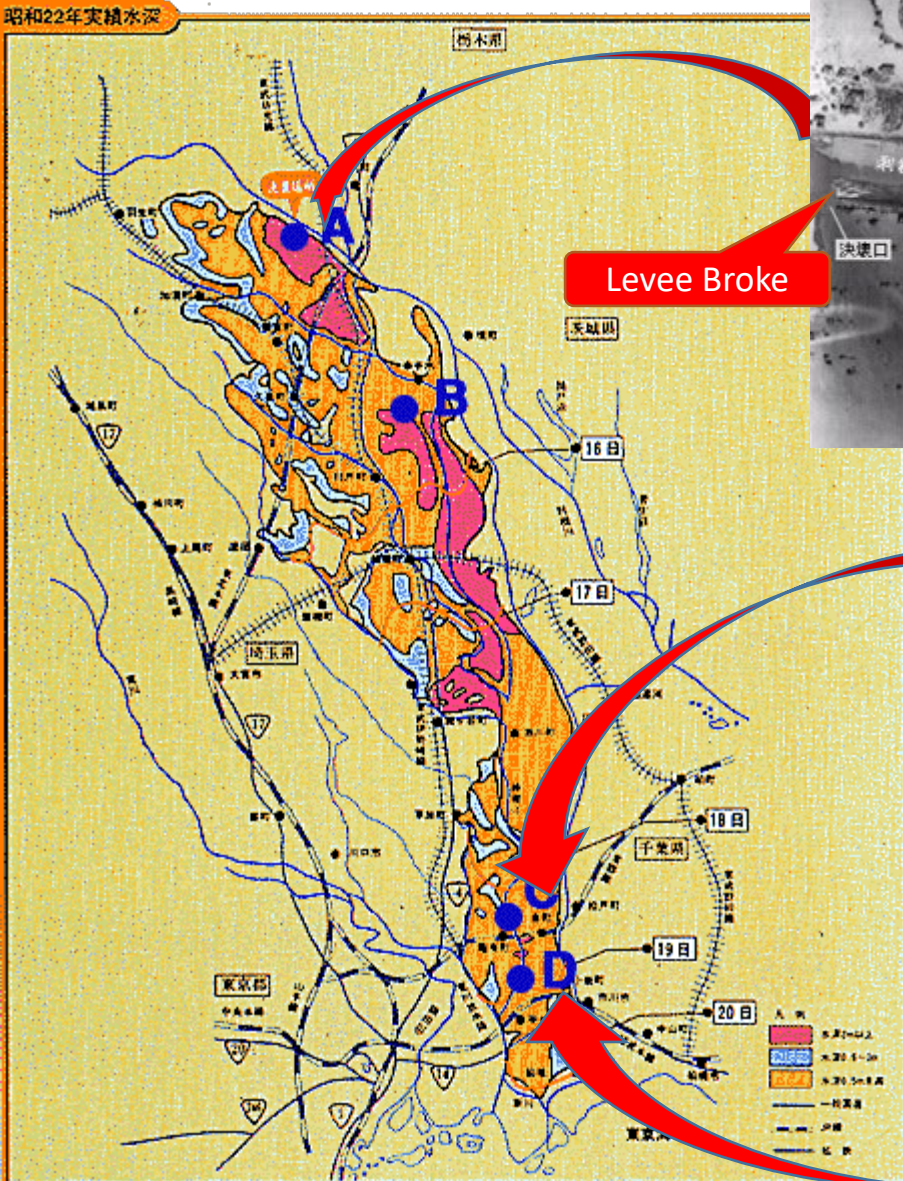


Severe Damage by Series of Typhoons

Year	Typhoon	Death Toll
1945	Makurazaki Typhoon	3,756
1947	Kathleen Typhoon	1,930
1948	Ion Typhoon	838
1950	Jane Typhoon	539
1951	Ruth Typhoon	943
1954	Toyamaru Typhoon (with big ferry shipwreck)	1,761
1958	Kanogawa Typhoon	1,269
1959	Ise-wan Typhoon	5,098

Kathleen Typhoon, inundated Tokyo 19 Sep. 1947

440km² inundated, 1,930 casualties



Right levee of Tone River broke 16 Sept. at Ootone-town in Saitama, Floodwaters inundated downstream.

Photos by MLIT



Flooding in Adachi-ku, Tokyo 19 Sept.

Totally inundated Katsushika-ku Tokyo 19 Sept.



Kathleen Typhoon was a wake-up call for flood protection of urban areas in post WW II in Japan

- 1949 Flood Control Council in Ministry of Construction decided “River Improvement Plan” for 10 major river systems. It called for programmed flood control by dams.
- 1949 Flood Control Council proposed “Tone River Improvement Plan” which included construction of 10 dams in upstream and construction of anti-flood pond along Watarase river.



Multi-purpose Yagisawa Dam upstream in Tone River started construction in 1959 completed in 1967
131m high concrete arch dam, Japan Water Agency

- Flood control
- Agricultural water & Urban water supply
- Hydroelectricity



Watarase anti-flood pond

Ise-wan Typhoon, hit Nagoya 26 Sep.1959

Lowest pressure **894 hPa** , Max Wind Speed **75m/s**



Photo by Takahama

Ise-wan Typhoon landed midnight. Flooding from upstream and high tide & storm surge from the sea sandwiched the low-lying areas of Nagoya, resulted in huge casualties.

1959 Ise-Wan Typhoon was the 1st Epoch-Making Turning Point



Ise-wan Typhoon hit Nagoya, the 3rd largest metropolitan area in Japan. 5098 killed.

- Response oriented approach to **preventive approach**
- Individual approach to **comprehensive multi-sectoral approach**
- **Investment** for disaster reduction
- National, Prefecture and Municipal Gov'ts were given **responsibilities**

Disaster Countermeasures Basic Act 1961



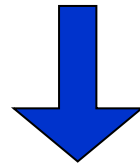
Enabled Investment for Disaster Prevention

- ◆ Flood Control & Land Conservation, Forest Conservation
- ◆ Meteorological Observation Mt. Fuji Rader Site, Meteo-Sats
- ◆ Emergency Telecommunication Systems
- ⋮

Institutionalization of
Disaster Reduction
Investments

Designation of “Disaster Prevention Day”

Public Awareness Programs, Disaster Drills & Exercises
1 September (Annual Nationwide Event)



**Great Success
in decreasing Typhoon & Flood Casualties**

Investing in Science and Technology for Disaster Reduction

Meteorological Radar



On top of Mt. FUJI 3776m high



10 March 1965,
The first high mountain
meteorological radar started
observation.

Severe Damage by Earthquakes(1945-1995)

Year	Earthquake (Magnitude)	Death Toll
1945	Mikawa Earthquake (M6.8)	2,306
1946	Nankai Earthquake (M8.0)	1,330
1948	Fukui Earthquake (M7.1)	3,769
1952	Tokachi-oki Earthquake (M8.2)	33
1960	Chile Earthquake & Tsunami (M8.5)	139
1964	Niigata Earthquake (M7.5)	26
1968	Tokachi-oki Earthquake (M7.9)	52
1974	Izu-hanto-oki Earthquake (M6.9)	30
1978	Izu-Oshima Kinkai Earthquake (M7.0)	25
1978	Miyagi-ken-oki Earthquake (M7.4)	28
1983	Nihonkai Chubu Earthquake & Tsunami (M7.7)	104
1984	Nagano-ken Seibu Earthquake (M6.8)	29
1993	Hokkaido Nansei-oki Earthquake & Tsunami (M7.8)	230
1995	Hanshin-Awaji <Kobe> Earthquake (M7.3)	6,437

Fukui Earthquake(M.7.1) 1948

3,769 casualties



内閣府防災災害教訓報告書

Wooden houses collapsed
caught fire



提供/福井市



福井県資料

Tokachi-oki Earthquake(M7.9) 1968

52 Casualties



Collapsed RC buildings

Miyagi-ken-oki Earthquake(M7.4) 1978

Sendai City Experience

28 Casualties



Crashed concrete block wall
**school children crushed
to death**



Pancake-collapsed building

Evolution of Japan's Anti-Seismic Building Code

- 1923 The Great Kanto Earthquake (M7.9: Tokyo devastated 105,000 dead)
- 1924 **First Seismic Building Code**
- 1948 Fukui Earthquake (M7.1: 3,769 dead)
- 1950 **Building Standard Law**
- 1968 Tokachi-oki Earthquake (M7.9: 52 dead)
- 1978 Miyagi-ken-oki Earthquake (M7.4: 28 dead)

1981 Revision of Building Standard Law requirements:

- No damage against medium scale (JMA scale 5+) earthquakes,
- To be able to continue use after these medium earthquakes.
- No collapse & safety of people inside against large scale (JMA scale 6+ to 7) earthquakes

- 1995 Hanshin-Awaji(Kobe) Earthquake (M7.3: 6,347 dead)
- 1995 **Revision of Building Standard** (encourage metal reinforcement to wood joints)
- 2000 **Revision of Building Standard** (ground strength check made mandatory)

JMA scale 5+ ⇒ almost equivalent to Mercalli scale VII
JMA scale 6+ to 7 ⇒ almost equivalent to Mercalli scale VIII to IX

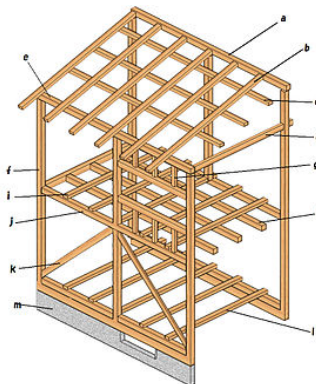
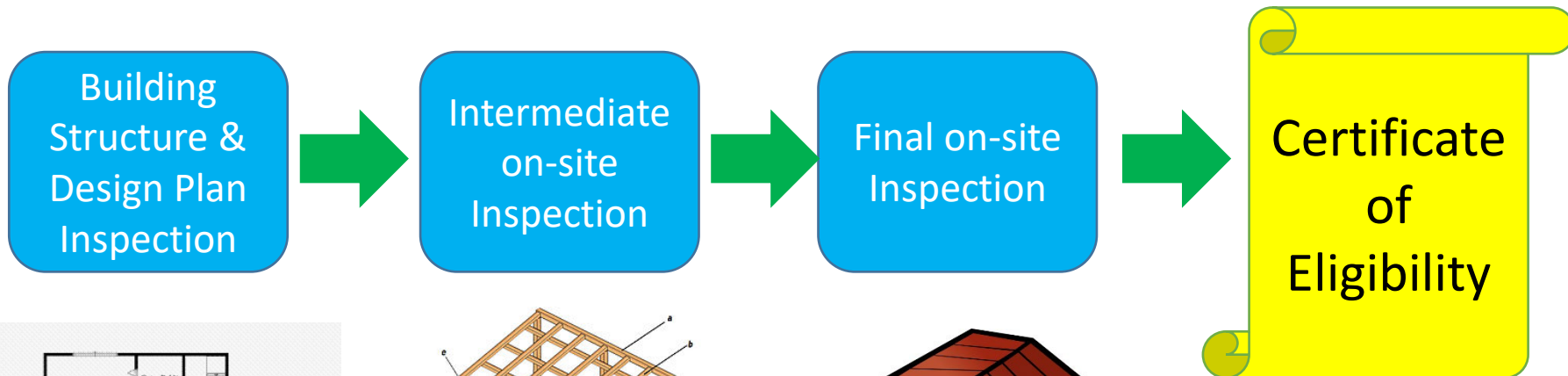
Enforcement of Building Safety Codes, How?

Inspection of Seismic Building Safety, Why Practiced in Japan?

Average worker needs long term housing loan to obtain his house. Approx. 5X of annual salary
Low interest loan by Government Housing Loan Corporation (established in 1950).

Aim of Government Housing Loan Corporation: to assist the improvement of housing quality.

Eligible for HLC loan or not: **A big difference in loan interest.**



Proof of Quality

Incentives to Build Houses according to Safety Codes

1995 Hanshin-Awaji (Kobe) Earthquake (M7.3) was the 2nd Epoch-Making Turning Point

Fire in a city center



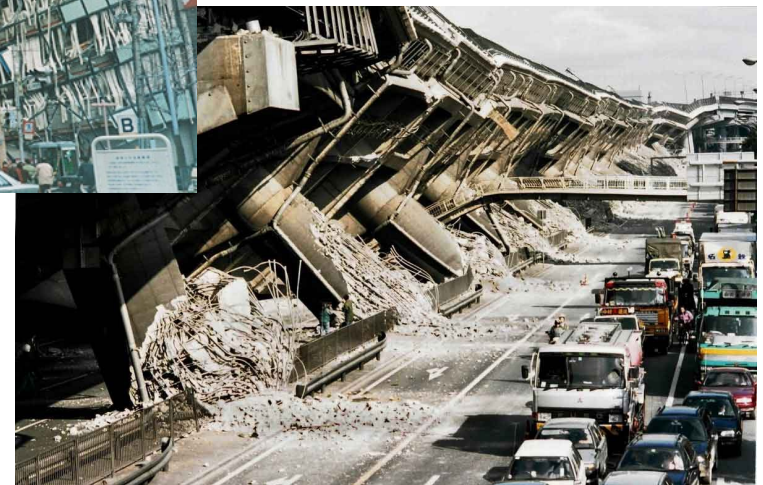
Collapsed houses



Damaged office building



Damaged railway track



Collapsed viaducts of an expressway

6,437 Casualties

Old timber structure with heavy tile roofs collapsed, crushing residents to deaths, Blocked the streets.



Old RC structure condominiums built before 1981 collapsed



- Collapse of houses not only kills people inside,
- Loss of shelter,
- But also debris blocking streets & reconstruction
- Existence of debris depress the affected population.

Kobe Municipal Government Headquarter

Built after
1981 Building
Standard

Built before
1981 Building
Standard



Lesson1: Collapse of old houses built before 1981 standard was the main cause of death

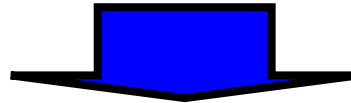
5,520 direct deaths (+917 relevant deaths)



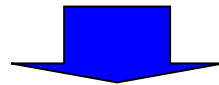
83% immediately killed by building collapse

total 6,437 victims

surgeon general's autopsy report



Prevention & Mitigation



Ensure Building Safety !

Preparedness



Public Awareness
Disaster Manager's
Proper Action

1995 new Act on Seismic Retrofitting of Existing Buildings

Public awareness campaign on housing seismic safety

Public campaign on affixing furniture and room safety

Damage to Kobe City Hall main building



Difficultly in Communication at HYOGO Prefecture Headquarter



Lesson 2: Delay of First Response due to lack of information at the direct hit Kobe city

- Damaged Local Government Headquarter
 - Local Government Command initially paralyzed
 - Destroyed almost all traffic system
 - Telecommunication, even satellite telecommunication system were cut off due to power failure
- ⇒ It took three days to grasp the entire picture of damage
- ⇒ The bottom-up reporting system could not function



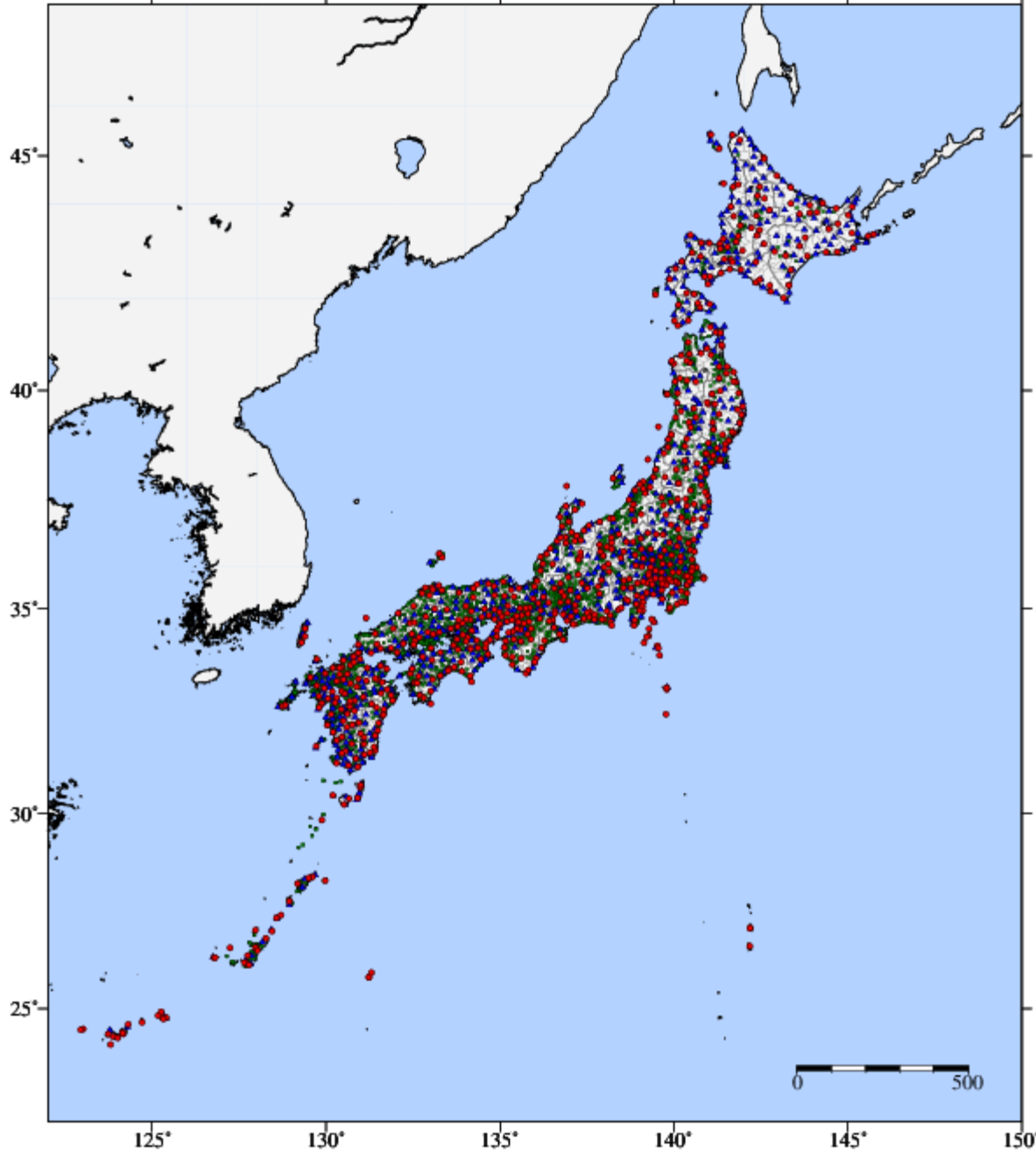
- Nationwide support system for local & regional emergency
- Appointment of Minister of State for Disaster Management
- High density seismometer network &
- Development of disaster damage estimation system (DIS)

Seismic Intensity Observation Points Increased

as of Oct. 2016

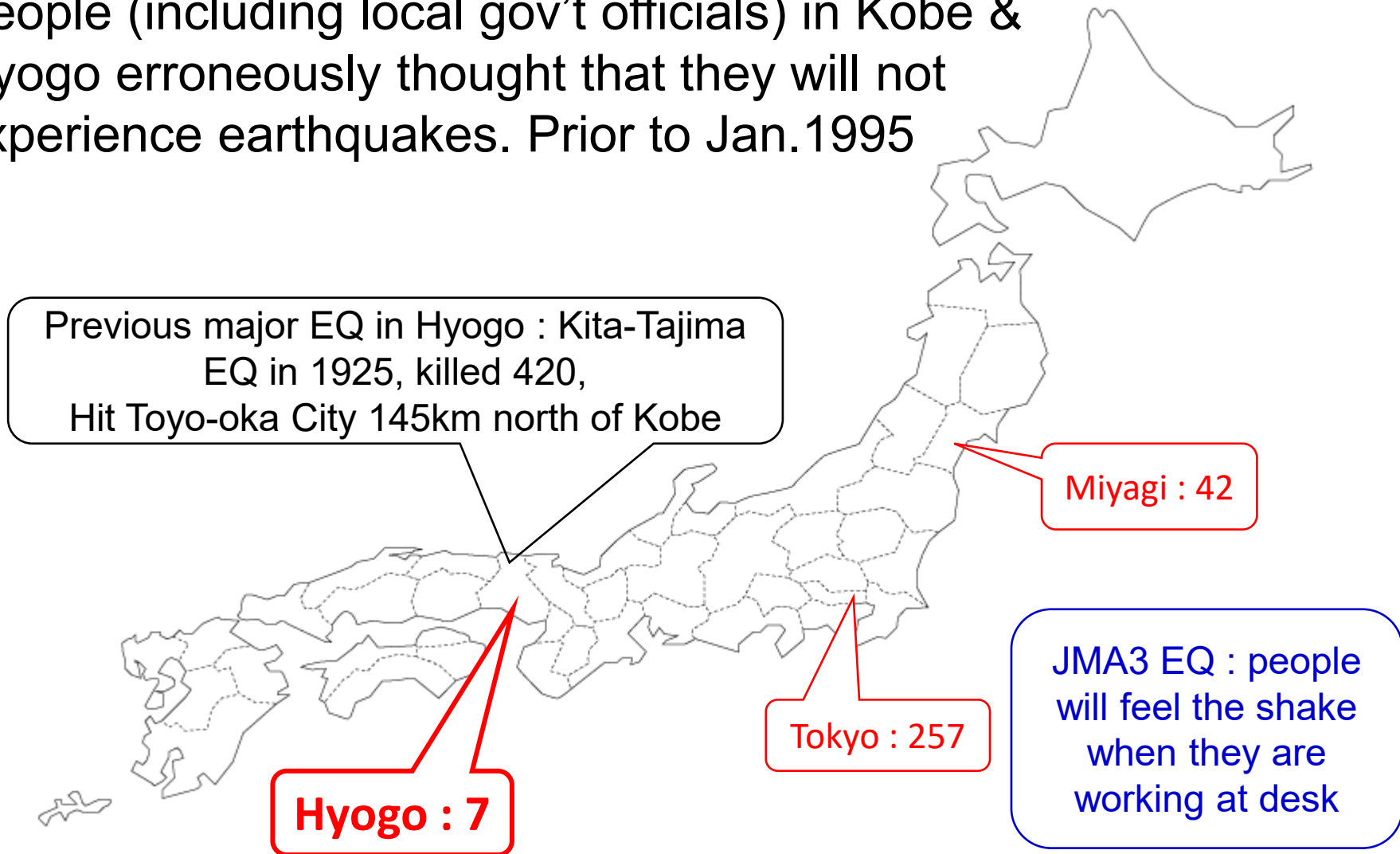
JMA:	672 points
Local Govt.:	2931 points
NIED:	785 points
total:	4388 points

(before the 1995 earthquake
JMA 150points)



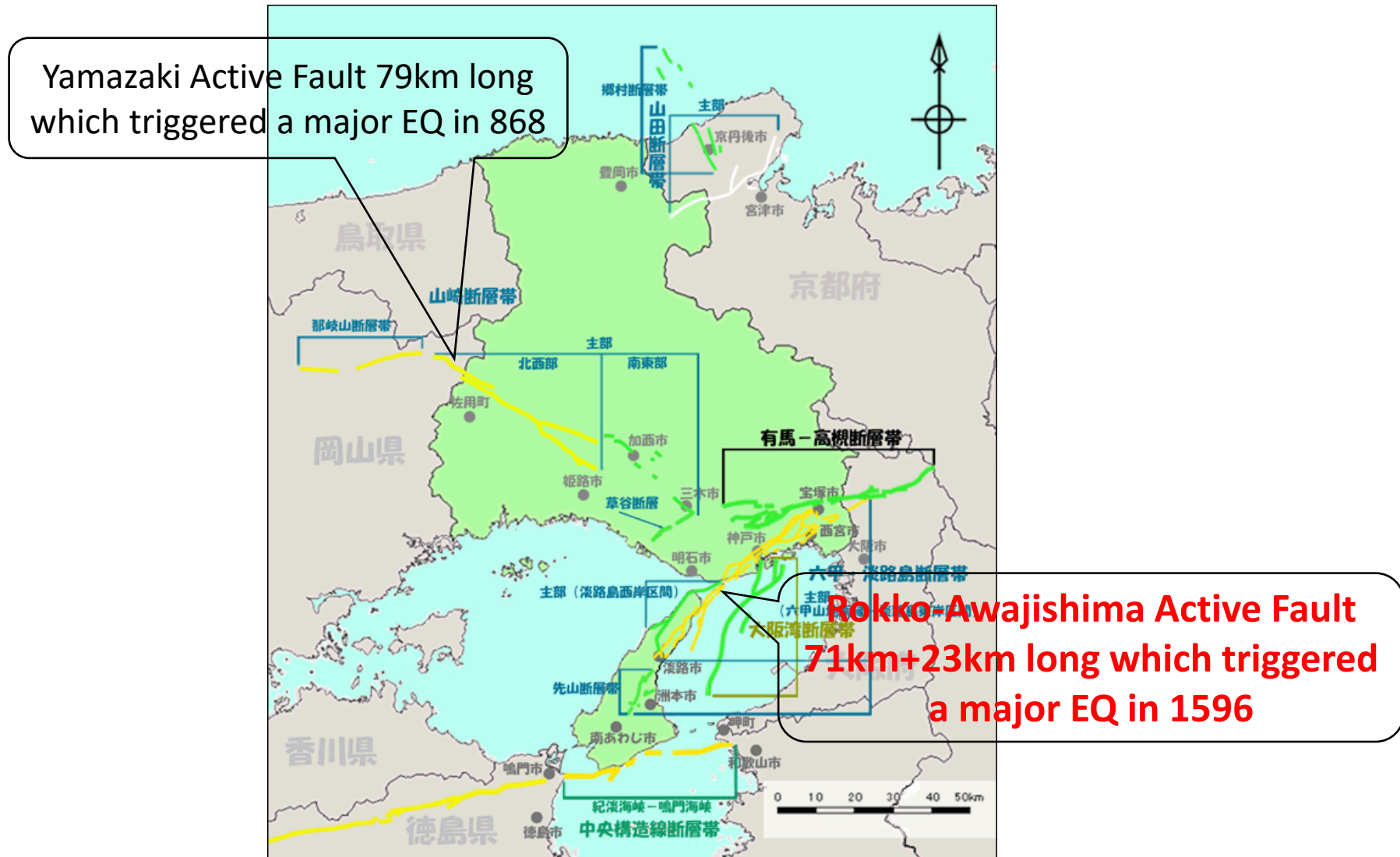
Biggest Lesson: Lack of Earthquake Awareness in Kobe & Hyogo

People (including local gov't officials) in Kobe & Hyogo erroneously thought that they will not experience earthquakes. Prior to Jan.1995



Number of EQs greater than JMA3 felt in 1985-1994

Existence of Active Faults in Hyogo were known to only a limited number of scientists



Lack of EQ Awareness meant Lack of Preventive Measures & Preparedness



Human Sufferings & Slow Response

Recollection by Mr. Sadao Tsunematsu, Principal Director of Reconstruction Hyogo Prefecture, in 2005 “Kindai-Shobo 2005 Vol 527, pp24-31”

- The previous experience of an earthquake in Hyogo was the “Kita-Tajima EQ in 1925” far to the north of Kobe, it was said that there is a slight possibility of an earthquake by Yamazaki fault in the western part of Hyogo, so, a strong earthquake in Kobe was a big surprise. Since Kobe has the Rokko mountains in the north, and the previous experience of 1938 Great Hanshin Flooding, we were thinking of flooding and landslides.
- Therefore, Hyogo prefecture government did not have 24/7 duty officer, we had procedure to increment emergency response according to weather forecast, so this system did not function in sudden onset earthquake.
- Since the Hyogo Prefecture Gov’t was located midst of the disaster site, we were in “blackout of information” at noon of 17 January, we were aware of only 200 casualties.

Paradigm shift after 1995 Hanshin-Awaji (Kobe) Earthquake

Most of the initial search & rescue done by family members and neighbors.
➡ How can we encourage disaster preparedness at community level?

Importance of building safety re-recognized.
➡ Who owns the houses and buildings?
Who can take care of safety inside the house or in the office?

Business Continuity Planning is important for reducing economic loss.
➡ Who decides on BCP of companies?

Importance of Pre-disaster measures re-recognized.
➡ Pre-assessment for each possible large scale earthquakes & floods.
Disaster reduction strategy based on pre-assessments.

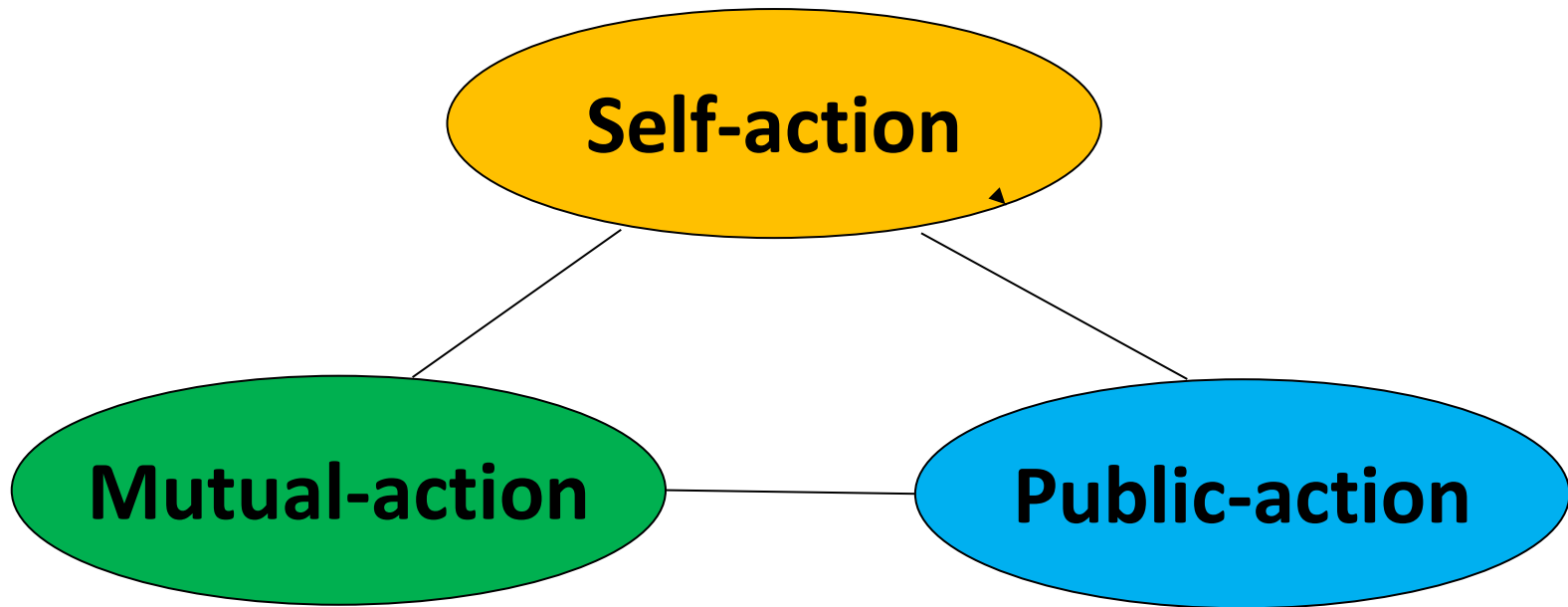
Government centered
disaster reduction



Multi-stakeholder approach to
disaster risk reduction

Paradigm shift after 1995 Hanshin-Awaji (Kobe) Earthquake

Call for a Nation-Wide Movement for Disaster Reduction Actions



Self-help action by individuals, families and companies
Mutual-help action at neighborhoods and local communities
Public-action by governments

Consumer's Awareness changes Advertisement of Condominium

阪神本線
深江

駅歩8分

1780万円(@83)

専71.72㎡ 間3LDK
築'98年5月 階9/12階
所神戸市東灘区深江南町3
セレーノ見附

洋6.1 洋6 物入
玄 物 LDK15.2
洋5.5

免震 追焚付
ウォークイン フローリング

北

“This condominium has **seismic base isolation** structure”

One of the 4 important sales points!

How can we create a win-win with the Private Sector ?

Risk Reduction = Reliability & Quality



If the public at large appreciate the added value of safety & resilience, and understand the science and technology behind the scenes;

Expenditures for Risk Reduction



Investment for Added Value

M9 Earthquake & Tsunami Came ! 2011

The 3rd Epoch-Making Turning Point



宮城小学校の屋上に避難した児童、教職員、地域住民

写真出典仙台市復興五年記録誌

Tohoku was prepared for a Miyagi-ken Oki EQ of
M7.6-M8.2,
but what came was M9 EQ & Tsunami

Energy of M9 earthquake is 32 times stronger than M8 earthquake
Enormous Destruction by the Tsunami !

Preventive Approach

Combination of Latest IT and Human Response

14:49 JMA issues first Tsunami Warning to Pacific coast of Japan

14:50 Tsunami Warning Screen Aired on NHK



15:14 JMA upgrades Tsunami Warning based on the off shore GPS buoy sea level observation. NHK immediately airs screen.

Tsunami Warning → Run! Disaster Education Tested!



Junior high school students helping elementary school children to run to high grounds in Kamaishi City.

Massive Evacuation !

Emergency Sirens for
Tsunami Warning



Elementary School on hilltop



Signs of Tsunami Evacuation Building



Approx. 500,000 people in the Tsunami inundated area. Majority escaped.

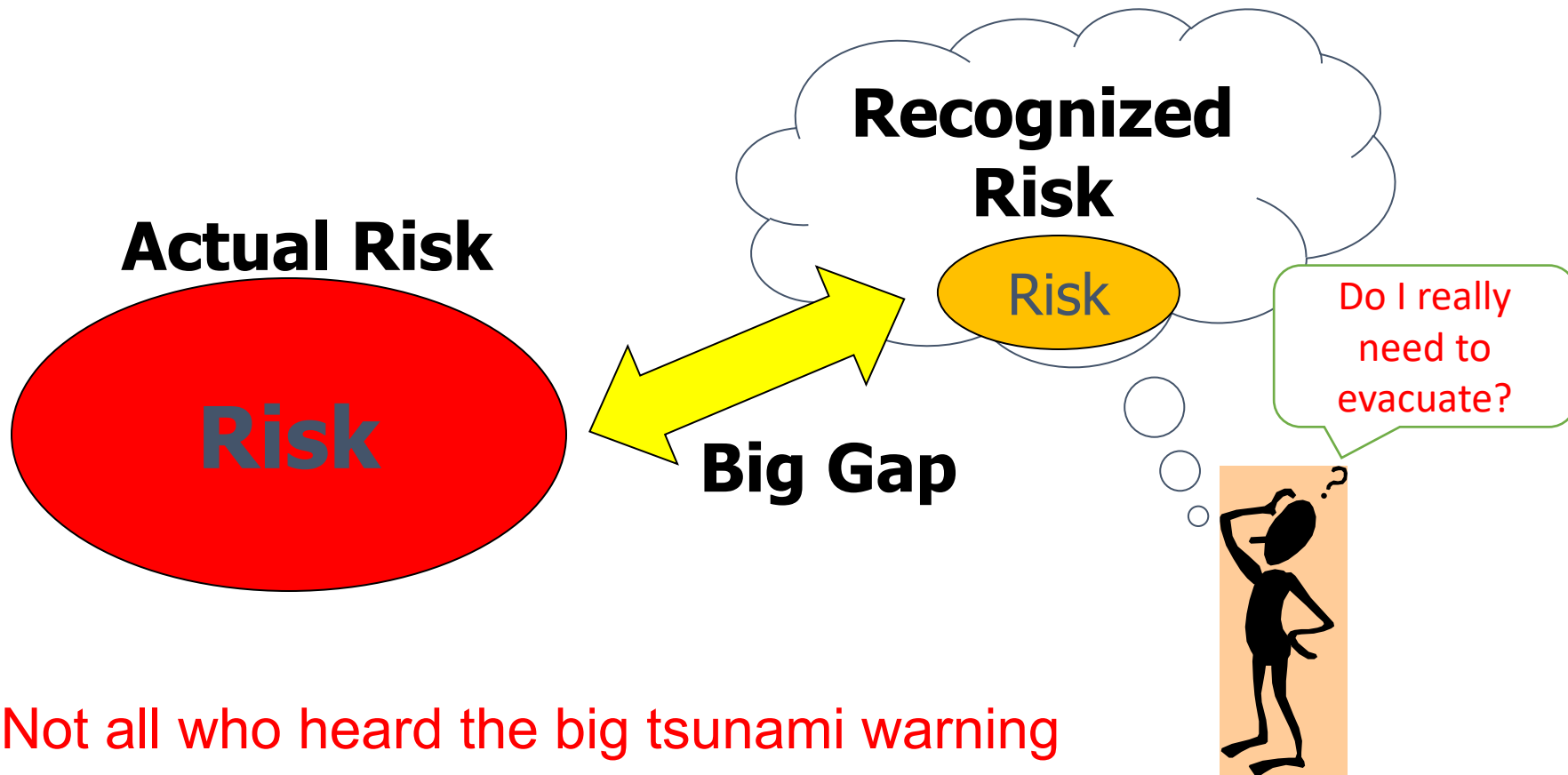
But 20,000 did not make it!

Mortality rate of Tsunami Inundated area
Indian Ocean Tsunami: 40%
Great East Japan EQ&Tsunami: 4%

Photos by ADRC

The Pitfall in Human Response!

Risk Perception Gap



Not all who heard the big tsunami warning started evacuation immediately.

How can we motivate individuals to take preventive action ?

- Disasters are not somebody else's affair.
- Do's and Don'ts preaching style educational materials do not attract adult's attention.

The tragic footages are not isolated events, it may be right behind you !

(the award winning poster of the 2005 competition)



'Ichi-Nichi-Mae (the Day Before) Project'

Application of Psychology

Initiated by S. Nishikawa in 2005

- Sincere personal stories generate sincere empathy to individuals in similar circumstances.
- This empathy will make them aware that they do have a possibility to be personally affected by a disaster.
- Once they recognize this risk, they will feel that they do not want to suffer similarly.
- This will work as a wake-up call for their preventive action.

➤ Interview people who were seriously affected by a disaster, who have responded to a disaster, by posing the question;

“ **What would you do if you were back the day before the disaster (Ichi-Nichi-Mae) ?**”

➤ Edit the most impressive personal stories into 200 to 600 word short stories; Add an indicative illustration

➤ Publish it on the Cabinet Office Disaster Management Website <http://www.bousai.go.jp/kyoiku/keigen/ichinitimae/index.html>

➤ **Free to download and use**

A Single facing Starvation after Earthquake

I Really Regret Unprepared Single's Life (The Great East Japan Earthquake, March 2011)

(Story by a company employee in the 30s, Sendai City)

The Earthquake came when I was working in my office. Everything in the office turned over and fell down. Fortunately nobody was injured in my office. I reported to the main office that we were all safe. I informed my parents that I was safe. I was lucky to get my e-mail messages through and felt relieved. Then I went home to my dormitory room. It was a terrible mess! Since I am single and living alone, I do not cook. I always dined outside or bought lunch boxes at nearby convenience stores. My refrigerator was always empty.

I asked my parents in the countryside to send me some food. But immediately after the earthquake, the package delivery service was not available.

So my relief food supplies did not reach me. Supermarkets and convenience stores had empty shelves. I nearly starved to death. I really recognized the importance of food stockpiling. If I was back the day before the Earthquake, I would buy canned food.



Application of 'Ichi-Nichi-Mae' for awareness of Mayors

Case study edited by FDMA Japan

Mayor regrets heavy drinking

It was mere luck that we had no casualties, Our initial response failed due to my drinking
(The Mt. Usu Volcanic eruption, March 2000) (Story by former mayor of Sobetsu Town, Hokkaido)

The response to the volcanic eruption of Mt. Usu in 2000 is often quoted as a success story of early warning and evacuation. But it was a mere luck, I must say.

The 1977 volcanic mud flow killed one of my daughter's classmate. This made me serious about volcanoes and I kept insisting that our town has to co-exist with the volcano. Our response to the 2000 volcanic eruption was a mere product of chance, and we barely secured our safety.

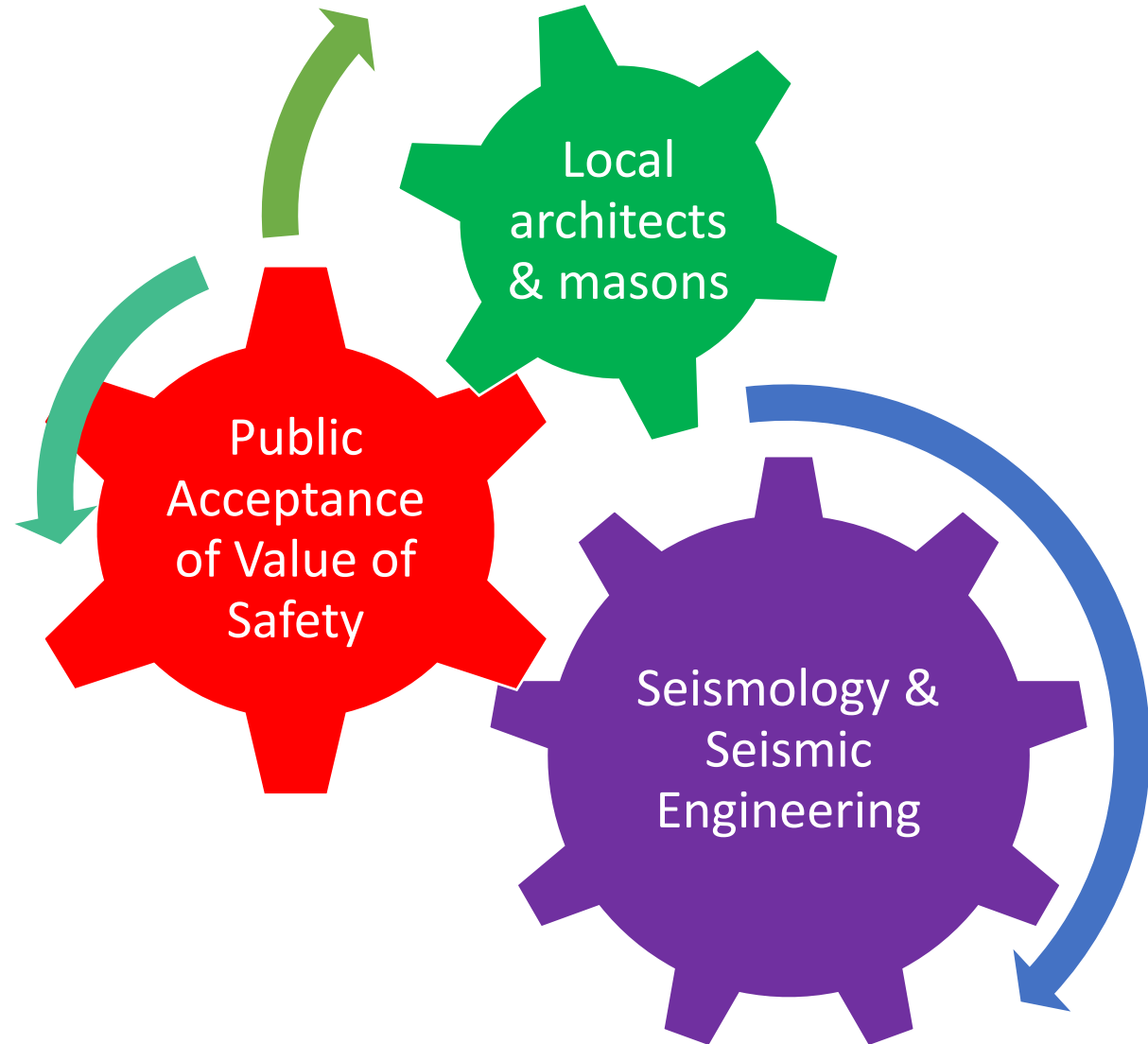
Before dawn on 28 March 2000, when I was informed that volcanic earthquakes are sharply increasing, I was heavily drinking in a local bar and was not able to rush immediately to my town office. I was aware that Mt. Usu tends to erupt within a few hours of volcanic earthquakes, but I couldn't make it to my office because of drinking.

Local mayors like me have many parties they must attend, so we must take caution. I really regret that I was in such a bad condition when I had to cope with a volcanic crisis.

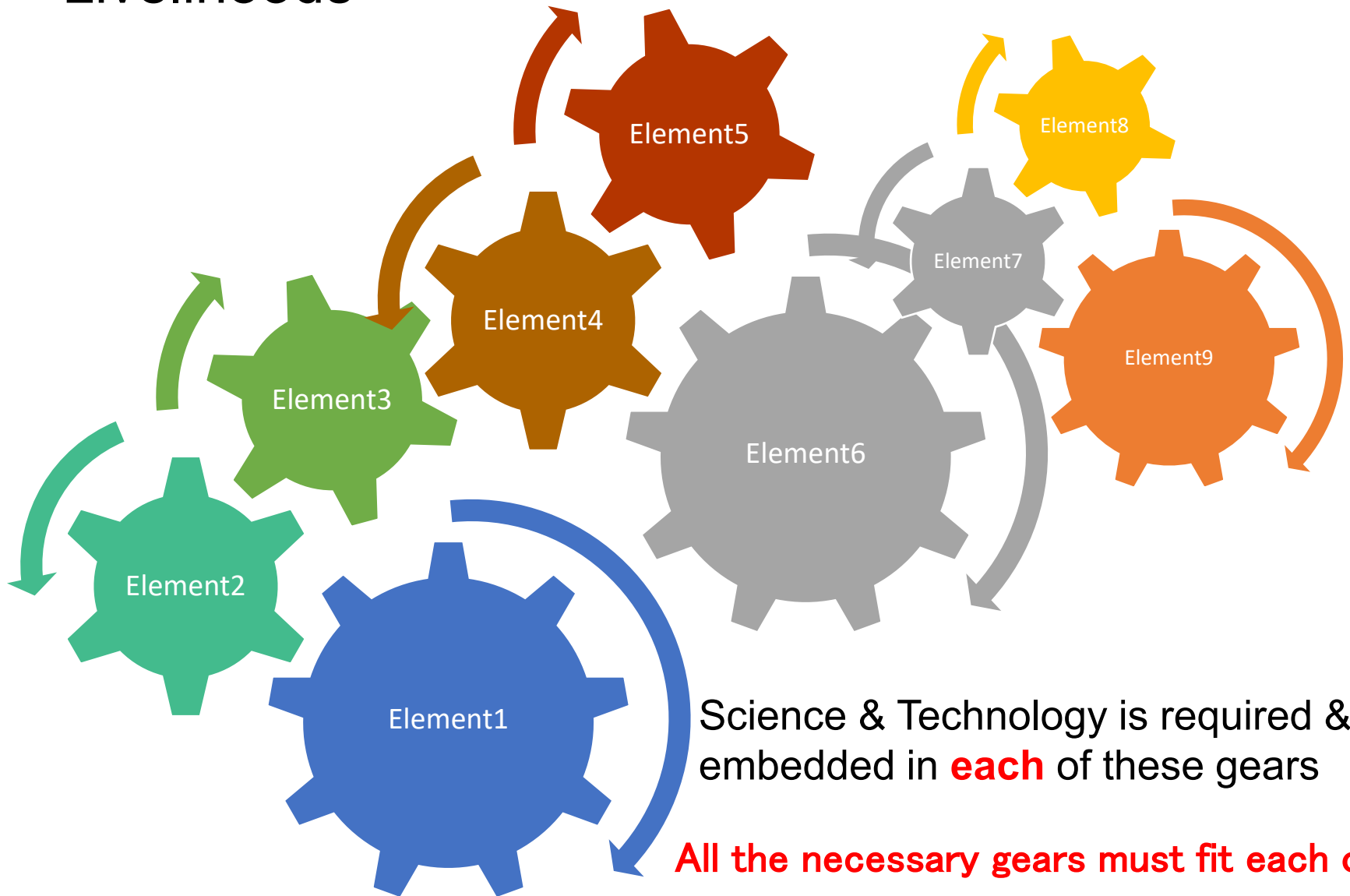
Luckily, as a result, there were 3 days before the real eruption and we were able to manage. But I still regret why I was in such a shameful condition on that day.



Some elements for earthquake safety of housing

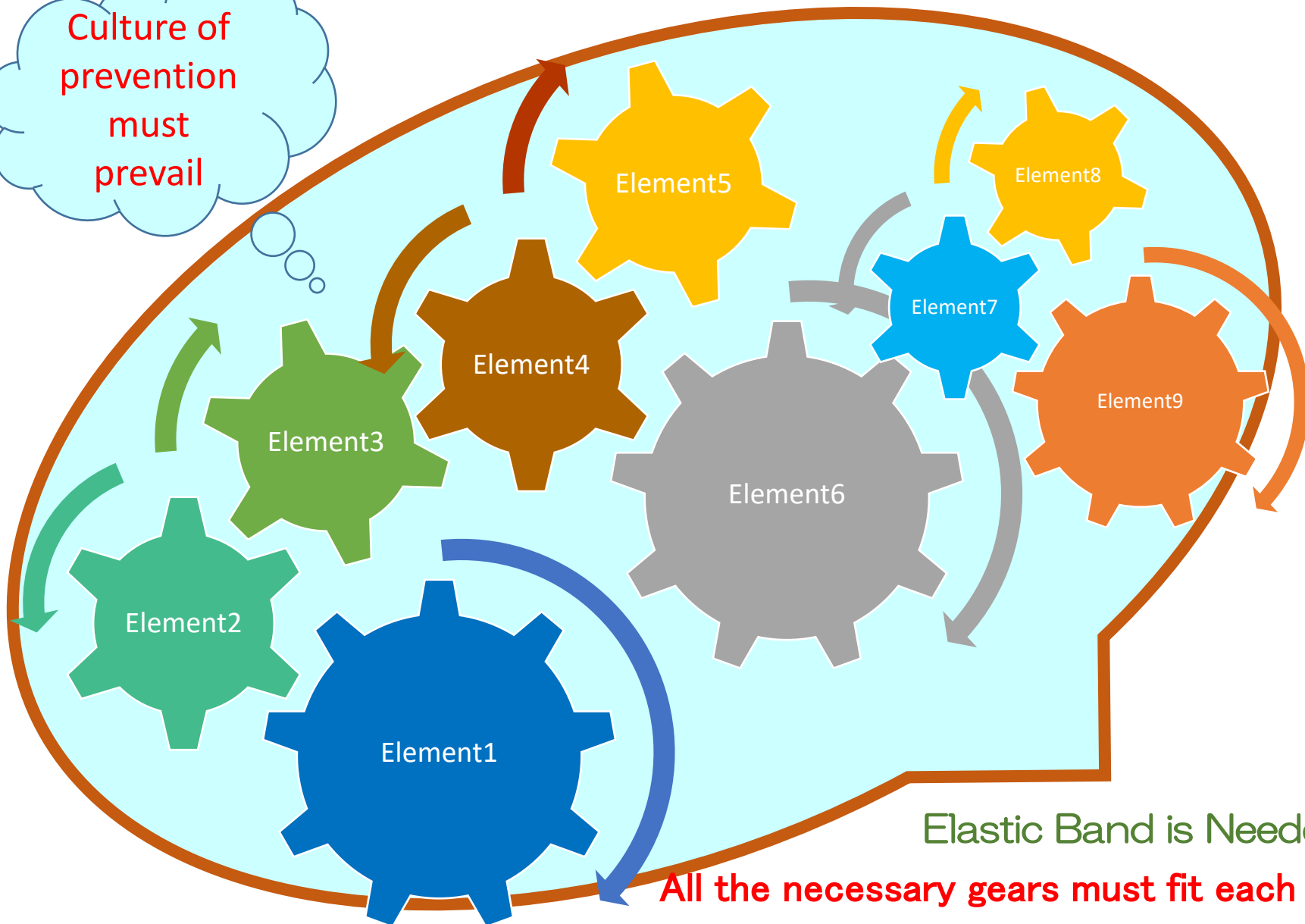


Numerous Efforts are Necessary to Save Lives and Livelihoods



Somebody Must Bundle Together Various Elements

Culture of prevention must prevail



Elastic Band is Needed

All the necessary gears must fit each other

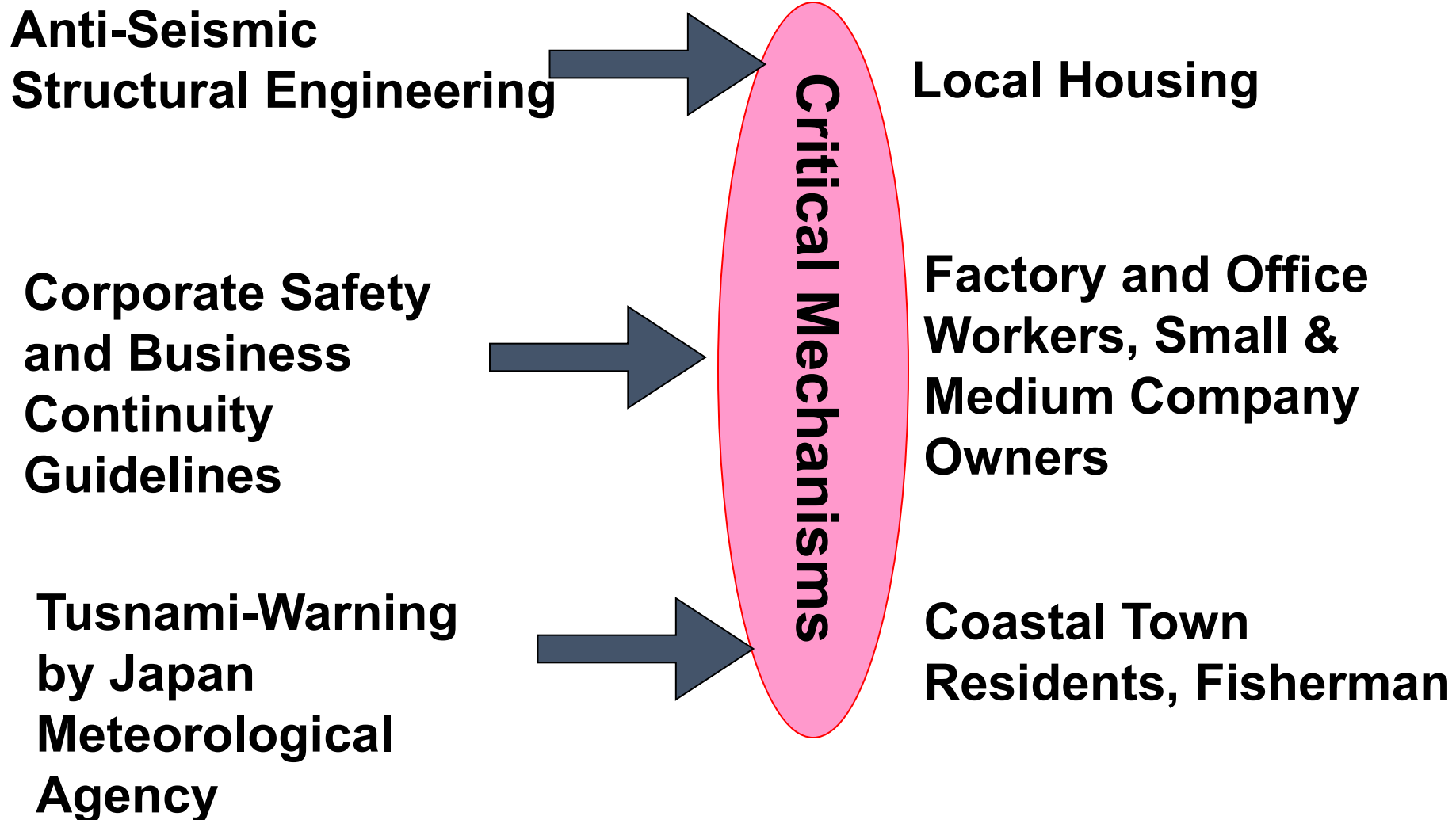
Institutionalization of Disaster Lessons ⇒ Legislation

How can
we
prevail?

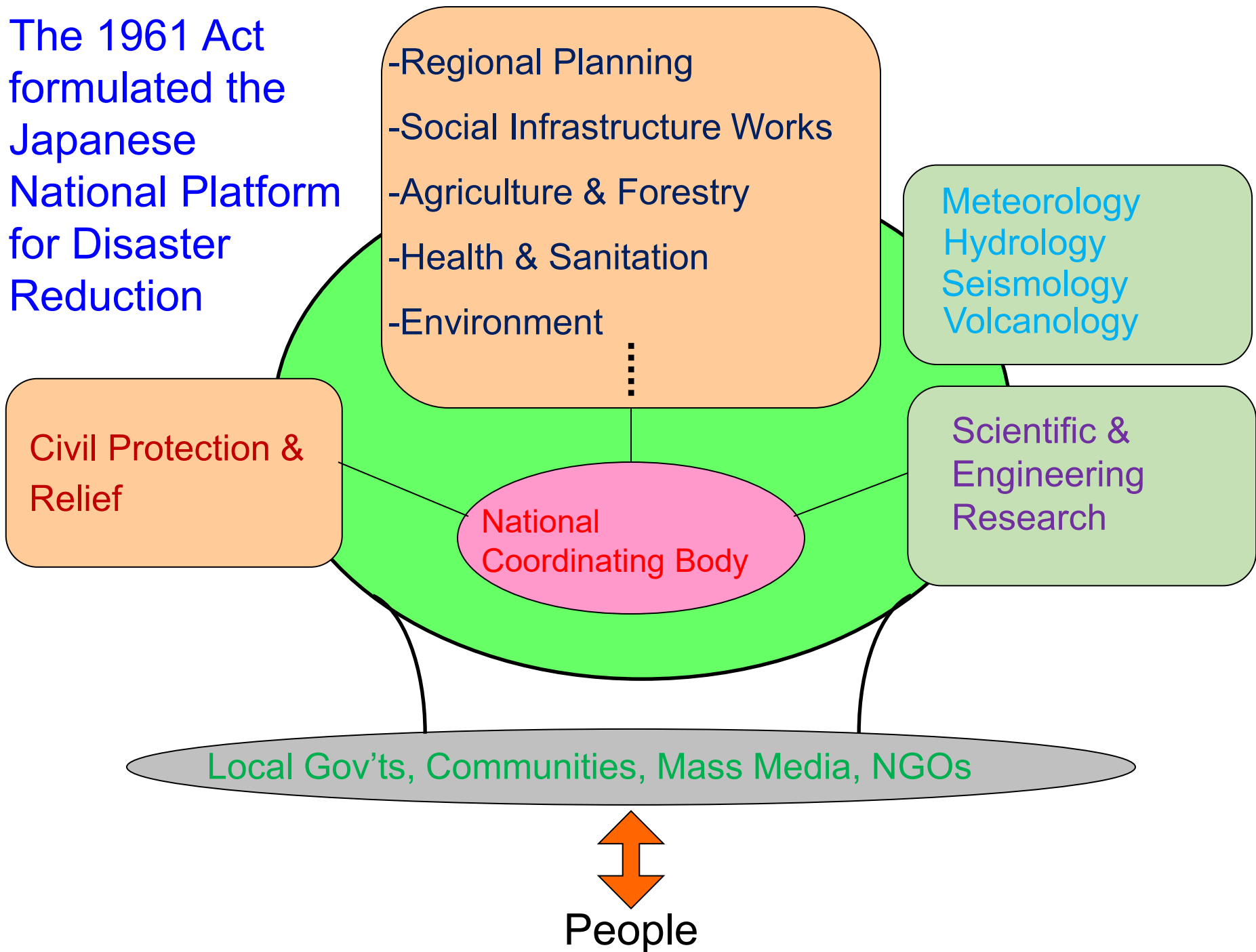
Who is
This?

This elastic band needs to be resilient
against numerous criticisms.

How can we really reach the people at risk?
How can the fruits of science benefit people ?



The 1961 Act formulated the Japanese National Platform for Disaster Reduction

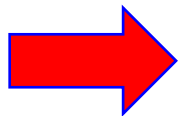


The Japanese Experience:

- Constant “Kaizen” (improvement) for DR
- Constant enlargement of participation
- Constant expansion of scope of DR

- Based on every bitter lessons learnt
- Including all of the priorities listed in HFA
- Applying all the scientific & technical knowledge
- By always trying to raise awareness of numerous stakeholders

Japan
Hosted



UN World Conference on
Disaster Risk Reduction

2015 Sendai Japan

To Share the
Experiences

Evolution of International Framework for Disaster Reduction

Yokohama Strategy for a Safer World :
Guidelines for Natural Disaster
Prevention, Preparedness and
Mitigation and its Plan of Action
1994

**Hyogo
(HFA)** Framework for Action 2005-2015:
Building the Resilience of Nations and
Communities to Disasters

Sendai Framework for Disaster Risk Reduction
2015-2030 (**SFDRR**)



UN World Conference on
Disaster Risk Reduction

14-18 March 2015, Sendai, Japan

Which do you prefer ?

When life is at stake.



Will the family members who lost their beloved ones be happy with insurance money after the funeral?

How can we take action before ?

Past Experiences + Appreciation of Risk



Imagination of Future Disaster & Tragedy
What if (your house collapse, school collapse, hospital collapse, bridge fall, road blocked ++) ?



Knowledge of Effective Preventive Methods



Action !

Culture of Prevention must prevail to encourage action for safety & resilience.

How can we better share the lessons learnt ?



November 2013



March 2011



September 2005

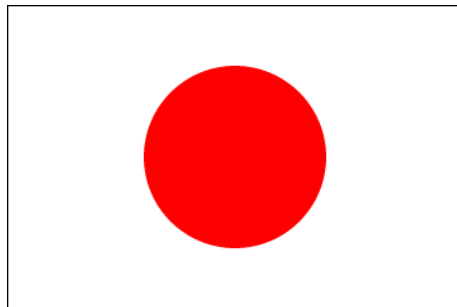
Proverb by Japanese Physics Scientist
Dr. Torahiko TERADA (1878-1935)
who investigated the damage by
1923 Great Kanto Earthquake



「天災は忘れた頃にやってくる」

**“Natural Disasters will hit us by the Time
people have forgotten about it”**

How to foster & inherit the Culture of Prevention



Thank you for your attention!