防灾减灾的弹性思考
Resilience Thinking of Disaster Prevention and Risk Reduction

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1. 多灾的世界

1.1 Rapid Change / 灾难

Disasters in recent years

Typhoon Haiyan, 2013/11/4, The Philipines

Snowstorm, 2014/2/14, Yamanashi, Japan

Landslide by Typhoon 26#, 2013/10/17, Izuoshima, Japan

Flood, 2013/10/7, Yuyao, Zhejiang, China

Subway station in New York is shown flooded with water during Hurricane Sandy. 2012/10/29

Thailand flood waters gain on Bangkok, 2011/10-11

China censors coverage of deadly Beijing floods. 2012/07/24

県内20万7000人避難指示

Emergent evacuation in Kyushu, Japan. 2012/07/12

Zud strikes Monglia, 2010

Sandstorm in Phoenix, 2012/9/7

Drought in China, 2010

Sea level rise, Venice, 2012/11/11

1.2 Creeping Change/ 渐变

Creeping change / 渐变

生态变化

空气变化

沙漠化

In Borno, desert encroachment is rarely spoken of, and then only in the context of Western China. Desertification is a major problem for those living in Borno state and off shores of the Lake Chad Basin in Chad, and indeed all of the countries at the southern edge of the Sahara Desert, from Senegal to Ethiopia.

水资源变化

The shrinking of the Aral Sea has been called "one of the planet's worst environmental disasters". The region's once prosperous fishing industry has been essentially destroyed, bringing unemployment and economic hardship. The Aral Sea region is also heavily polluted, with consequent serious public health problems.

Mega-Stress for Mega-Cities

A Climate Vulnerability Ranking of Major Coastal Cities in Asia

(Flooding)

OECD report:
Top 10 cities in the world risky to coastal flooding:
Kolkata and Mumbai in India;
Dhaka, Bangladesh;
Guangzhou, China;
Ho Chi Minh City, Vietnam;
Shanghai, China;
Bangkok, Thailand;
Rangoon (Myanmar), Burma; Miami, Florida, United States;
Hai Phong, Vietnam
(Nicholls et al. 2008).

Criteria compared for each city:

Environmental Exposure
- Storm threat (tropical cyclones, storm surge)
- Sea-level rise and subsidence
- Water (Flooding/drought)

Socio-Economic Sensitivity
- People per city
- Wealth (Gross Domestic Product)
- Contribution to national GDP

Adaptive Capacity
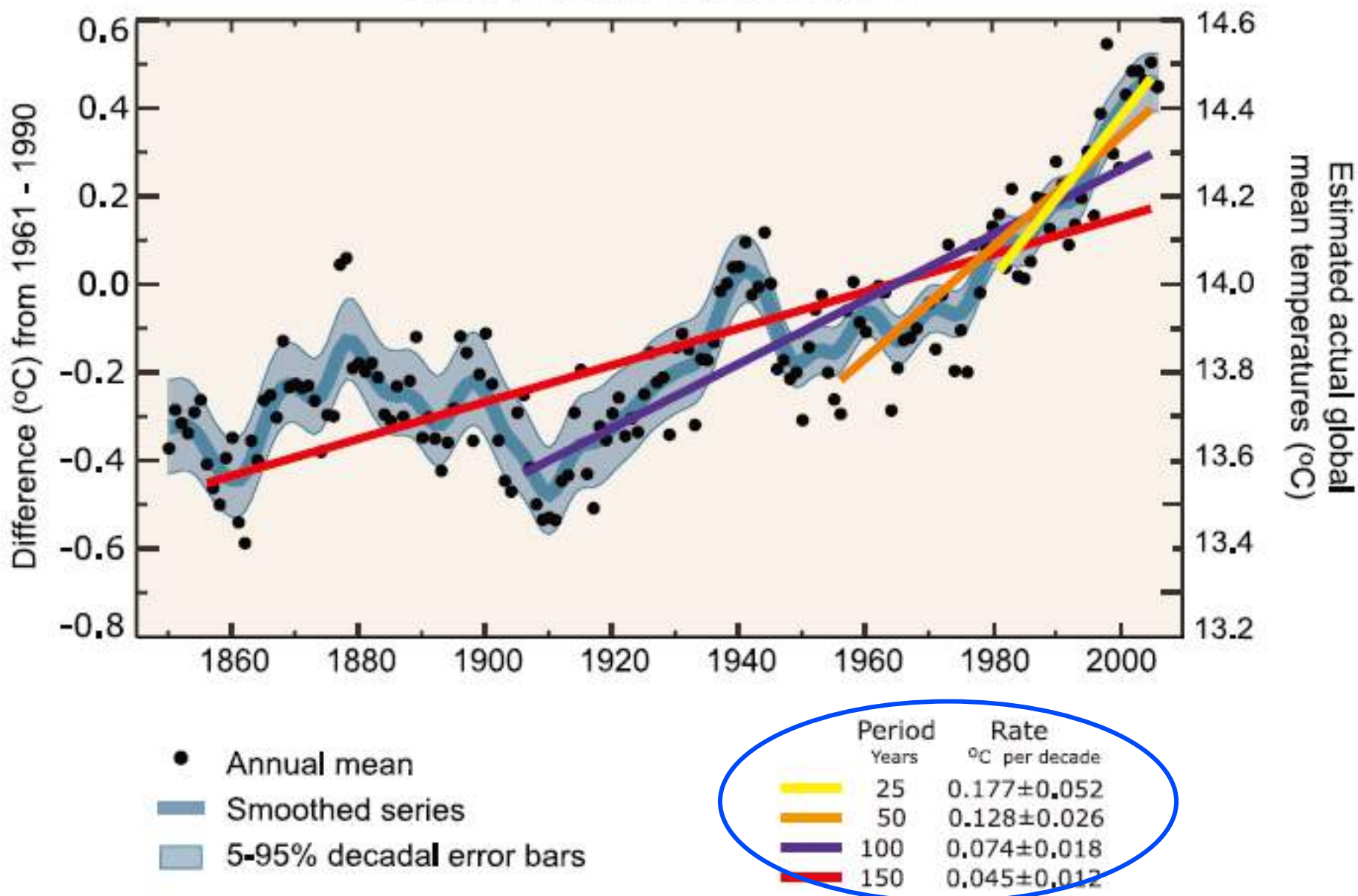- Existing examples
- Per capita GDP

(WWF, 2009)

Overall Vulnerability

Dhaka	Jakarta	Manila	Calcutta	Phnom Penh	Ho Chi Minh	Shanghai	Bangkok	Hong Kong	KL	Singapore
9	8	8	7	7	6	6	5	4	4	4

1840年以来的地球平均気温

Global Mean Temperature

Period	Rate
Years	°C per decade
25	0.177±0.052
50	0.128±0.026
100	0.074±0.018
150	0.045±0.012

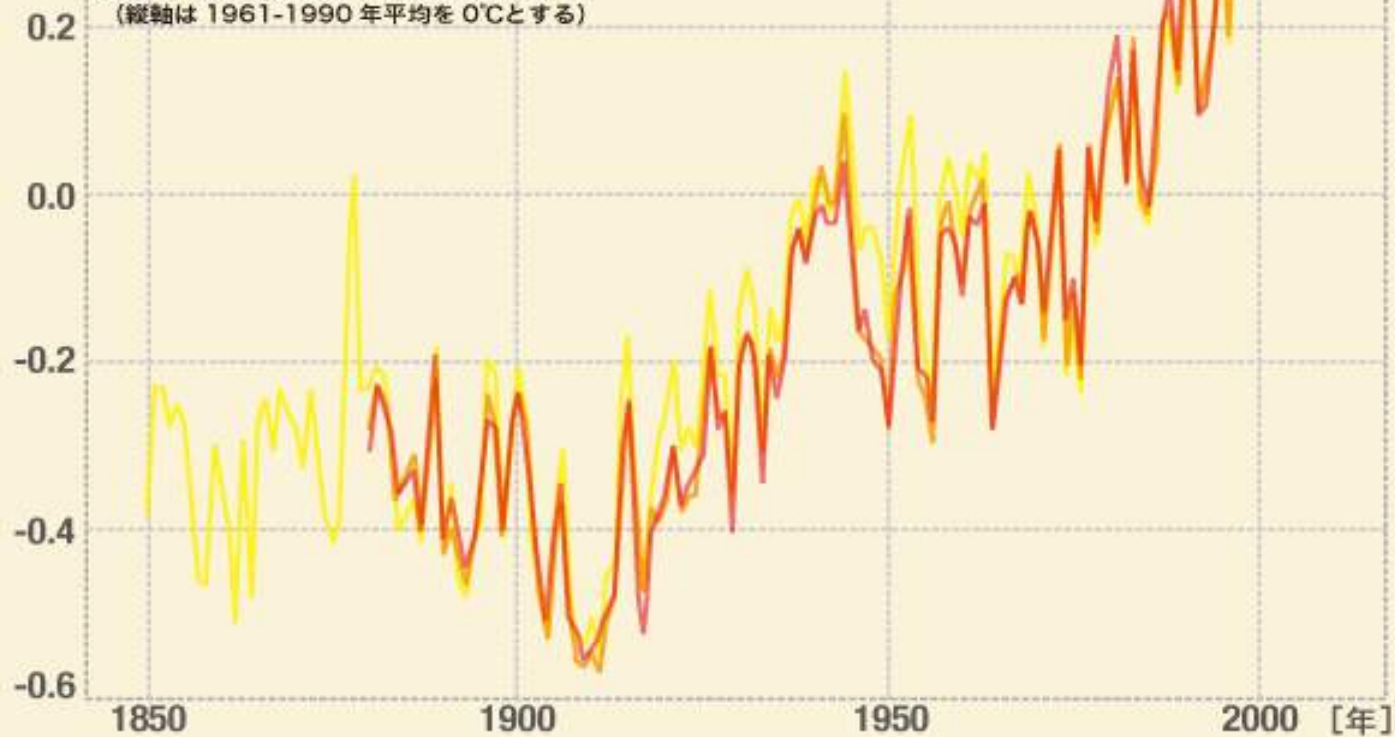- Annual mean
- Smoothed series
- 5-95% decadal error bars

[℃]

地球の気温はどのくらい上がったの？

0.85℃上昇
1880-2012年

世界の地上気温の経年変化（年平均）

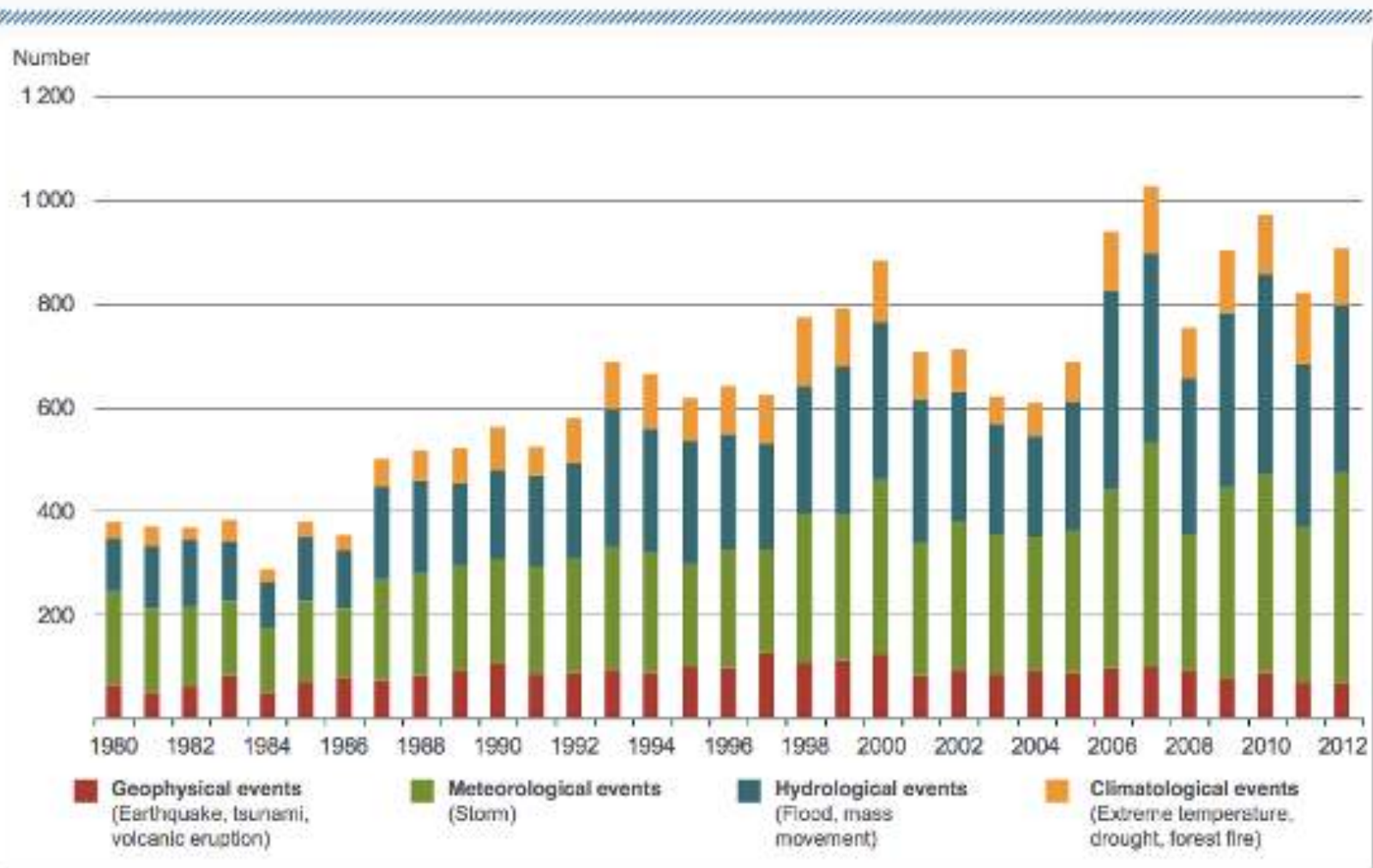出典）IPCC第5次評価報告書2013

※偏差の基準は 1961-1990 年平均
（縦軸は 1961-1990 年平均を 0℃とする）

1980-2012，自然灾害

渐变与突变

Catalysing event (E1)

Management adaptation (E2)

New event flags need for continuous adaptation (E3)

Upper and lower limits of coping capacity

Time series of climate attribute, e.g. precipitation

Trend in mean value of climate attribute, e.g. precipitation
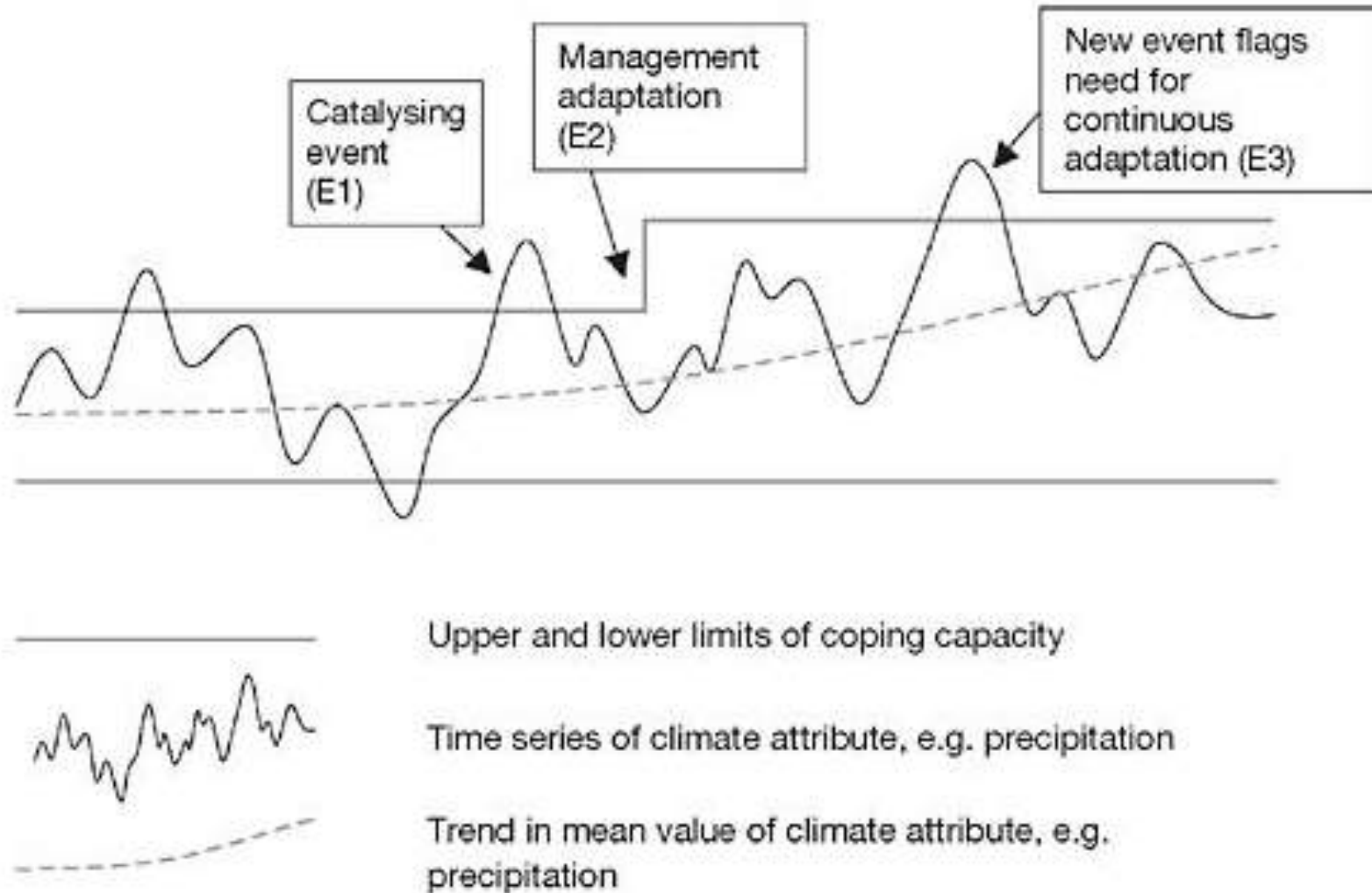
Pelling, Mark. 2011. *Adaptation to Climate Change: From Resilience to Transformation*. Routledge.
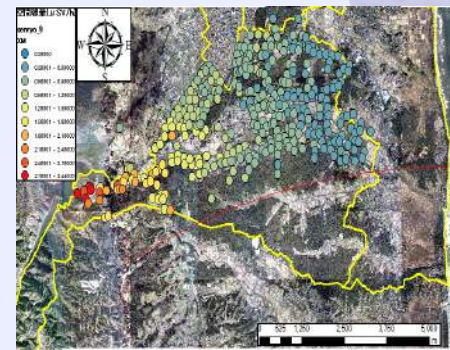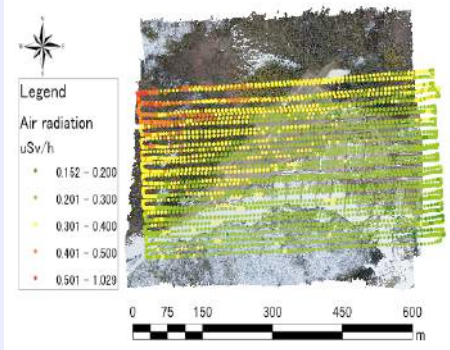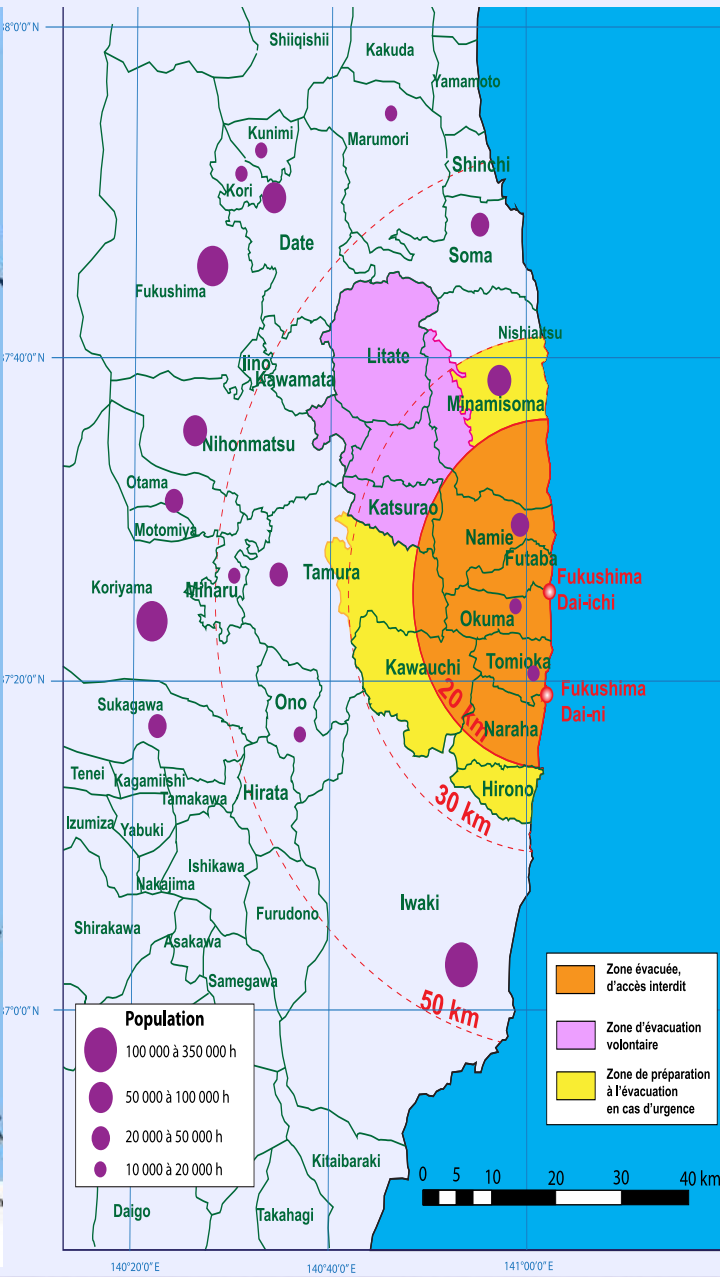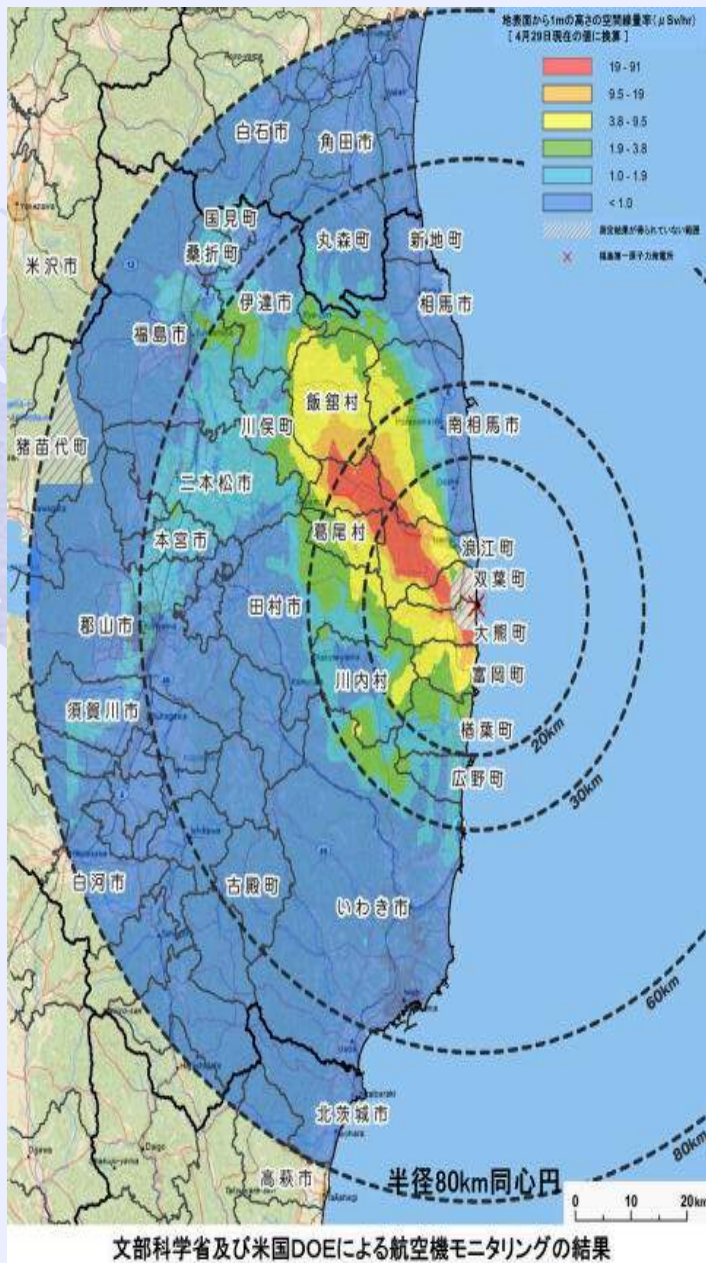http://www.amazon.co.uk/Adaptation-Climate-Change-Resilience-Transformation/dp/0415477514.

1.3 人为灾难 / Human Induced Disasters

Vulnerability of modern society

Radioactive Contamination of Fukushi Nuclear Reactors

南相馬市太田地区空間放射線量

现代风险社会
Risk Society
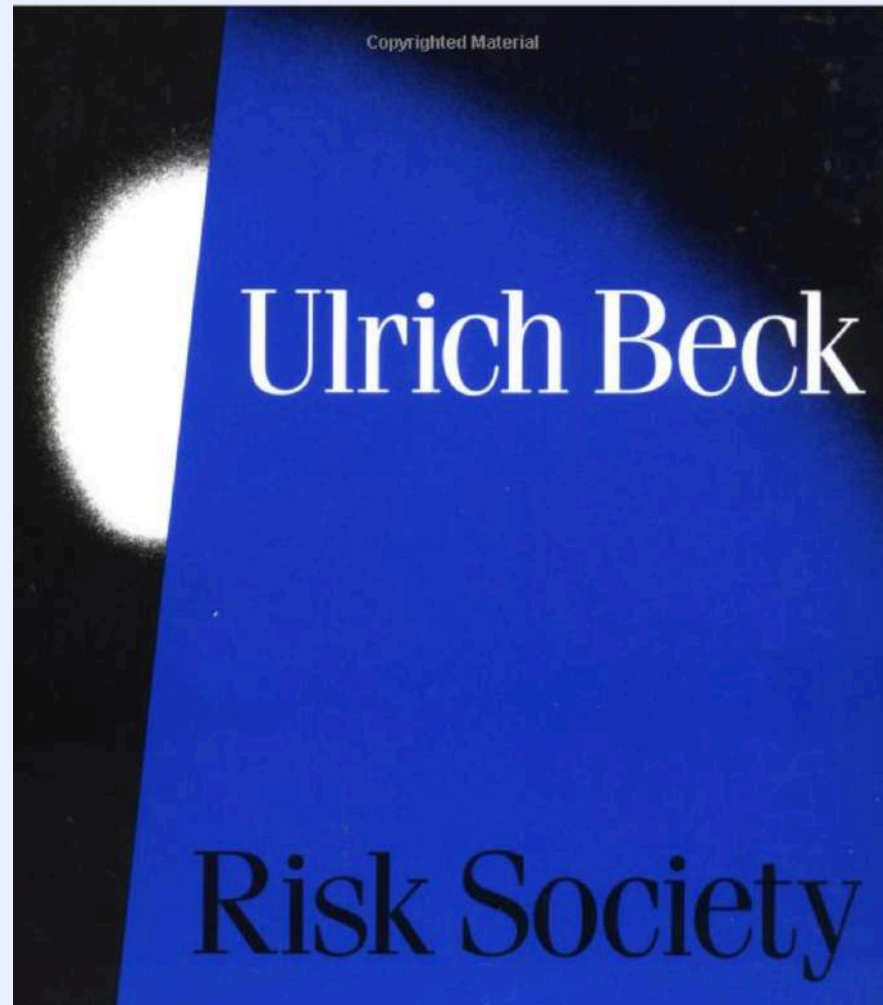
2．认知与对应

2.1 无知（Ignorance)

Itsukushima Shrine

Photo taken during site visit on 01/10/2012

- Itsukushima Shrine is a UNESCO World Heritage site and Japanese National Treasure
- It is located on the island of Itsukushima (also known as Miyajima) in Hiroshima Prefecture, Japan
- The shrine is built on posts sunk into the seabed that allow it to appear, at high tide, as if floating on the sea

Increasing Flooding Frequencies

Government Flooding Data 1989-2006

Source: Wise Adaptation to Climate Change, Ministry of the Environment (2008)
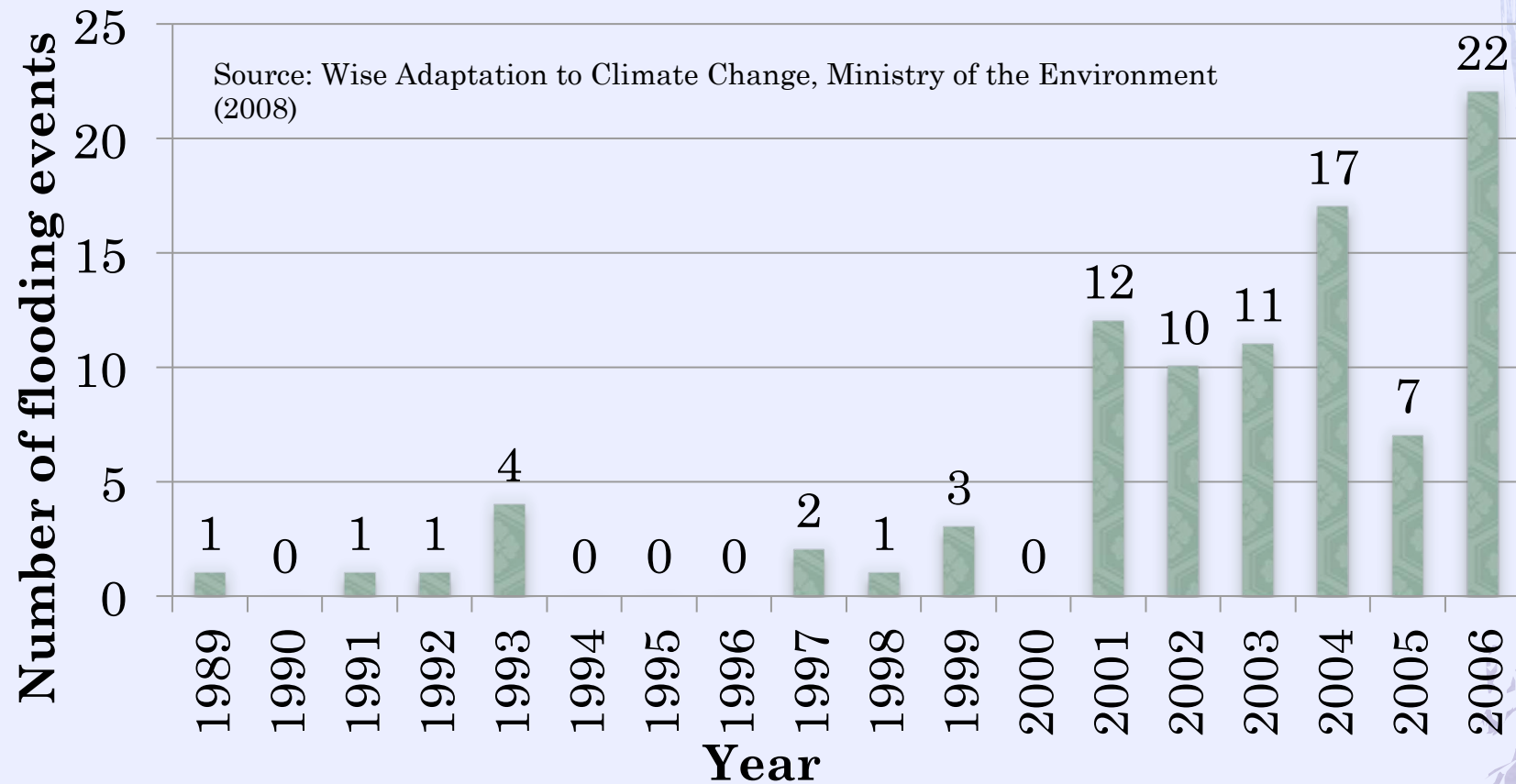
Tide Gauge Data Analysis

Monthly observed sea level at Hiroshima (December 1963-December 2011)

Source: JMA/ Permanent Service for Mean Sea Level

Source: JMA/ Permanent Service for Mean Sea Level

Year	Seto Inland Sea	Global
1960-2010	2.1mm	-
1961-2003	2.8mm	1.8mm[±0.6]
1993-2003	8.8mm	3.1mm[±0.7]
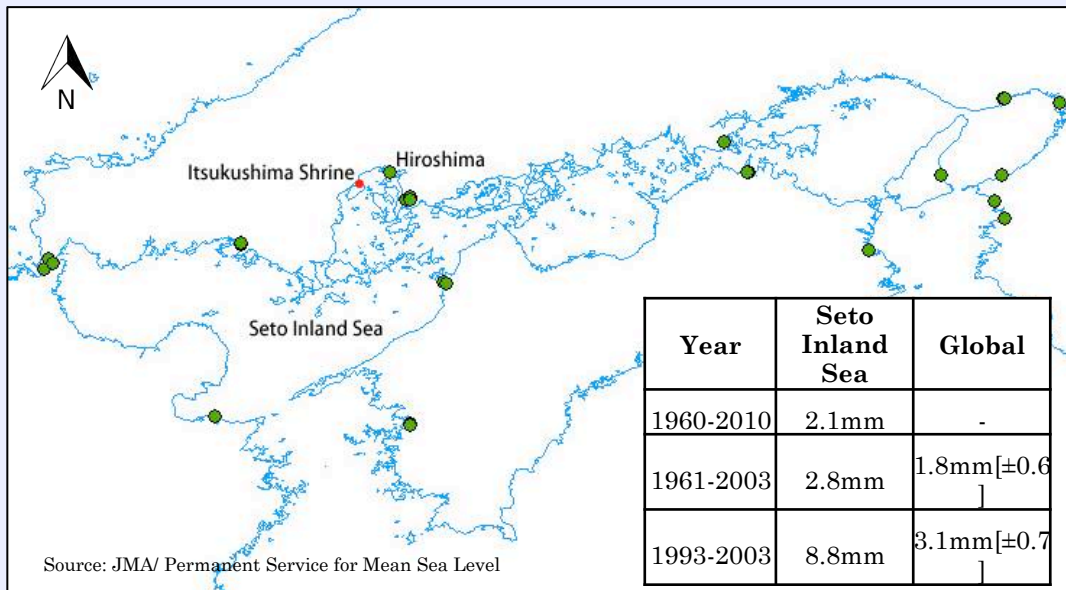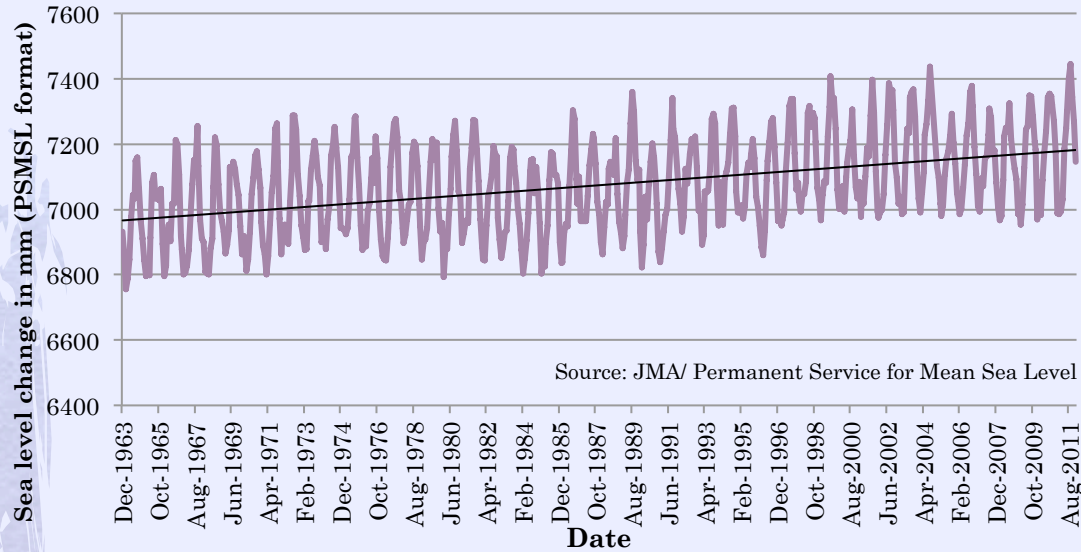
- Sea level at Hiroshima has steadily increased since data recording began in the 1960s (top left)

- Causes include decadal variation (JMA, 2008) and land subsidence (Tokeshi and Yanagi, 2004) making it difficult to attribute recent rise to climate change

- Hiroshima is not an isolated case - sea levels in the Seto Inland Sea rising faster than the global average (bottom left)

Interviews with Key Stakeholders

Organization	Concerned about climate change?	Access to unbiased climate change information?	Know where to find out about climate change?	Additional information
Itsukushima Shrine Organization	✓	✗	✗	• **No standardized tide monitoring system** • Climate change not part of management plan, despite UNESCO recommendations • No studies on long-term impacts of increased flooding
National Shrine Organization	N/A	N/A	N/A	• Unable to respond to proposed interview questions - no knowledge of climate change

Different Flooding inventories

Shrine Organization Flooding Data 1989-2009

Source: Itsukushima Shrine Organization (2012)

Number of flooding events

1989: 0
1990: 0
1991: 1
1992: 1
1993: 2
1994: 0
1995: 0
1996: 0
1997: 2
1998: 0
1999: 4
2000: 0
2001: 6
2002: 9
2003: 5
2004: 11
2005: 3
2006: 10
2007: 2
2008: 2
2009: 12

Year

Government Flooding Data 1989-2006

Source: Wise Adaptation to Climate Change, Ministry of the Environment (2008)

Number of flooding events

1989: 1
1990: 0
1991: 1
1992: 1
1993: 4
1994: 0
1995: 0
1996: 0
1997: 2
1998: 1
1999: 3
2000: 0
2001: 12
2002: 10
2003: 11
2004: 17
2005: 7
2006: 22

Year

Lessons learnt from this story

- Awareness of climate change risk is very limited at all levels in Japan.

- Knowledge gap between scientific research and implementation on the ground.
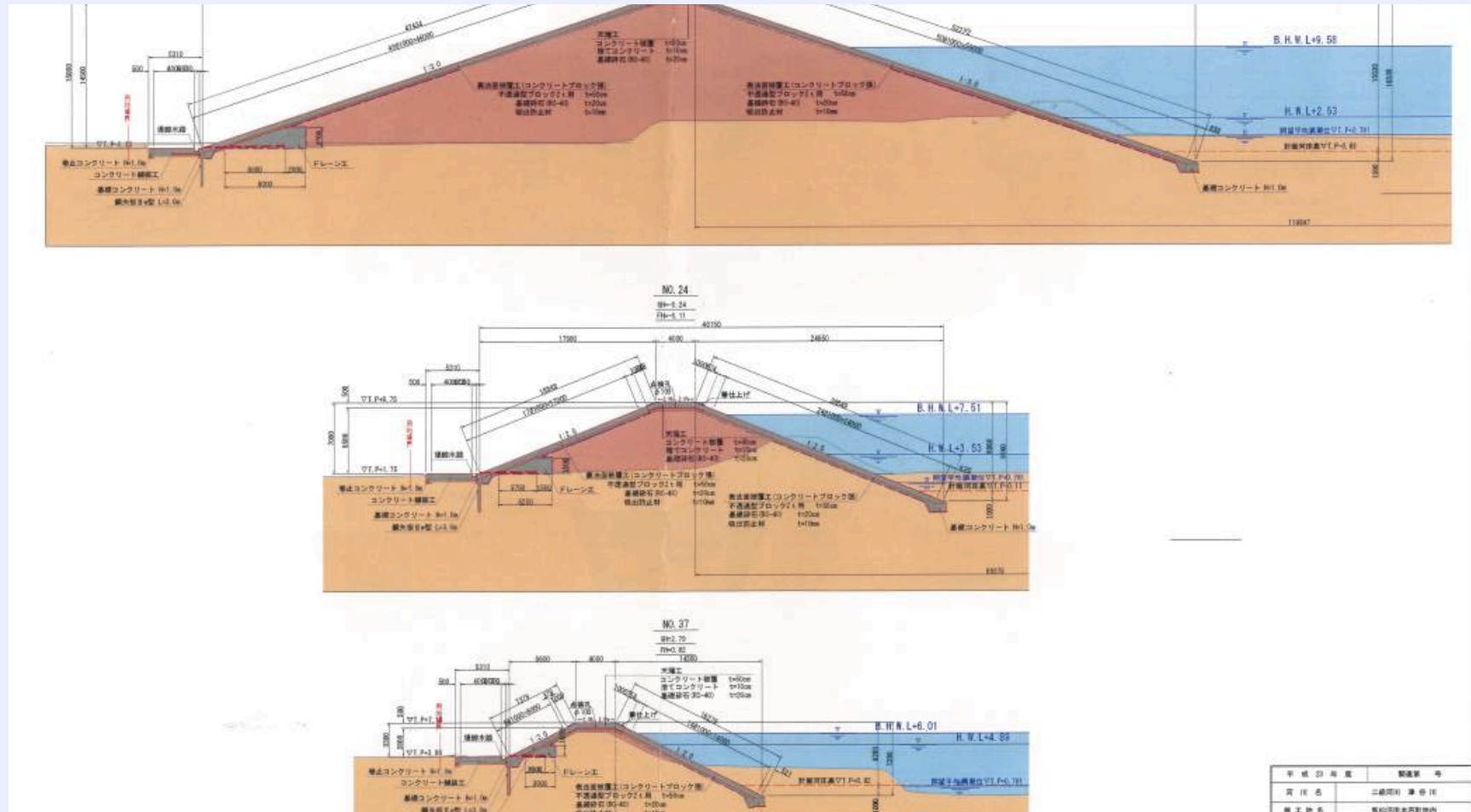
- No standardized guidance for inventorying damage in and out of organizations.
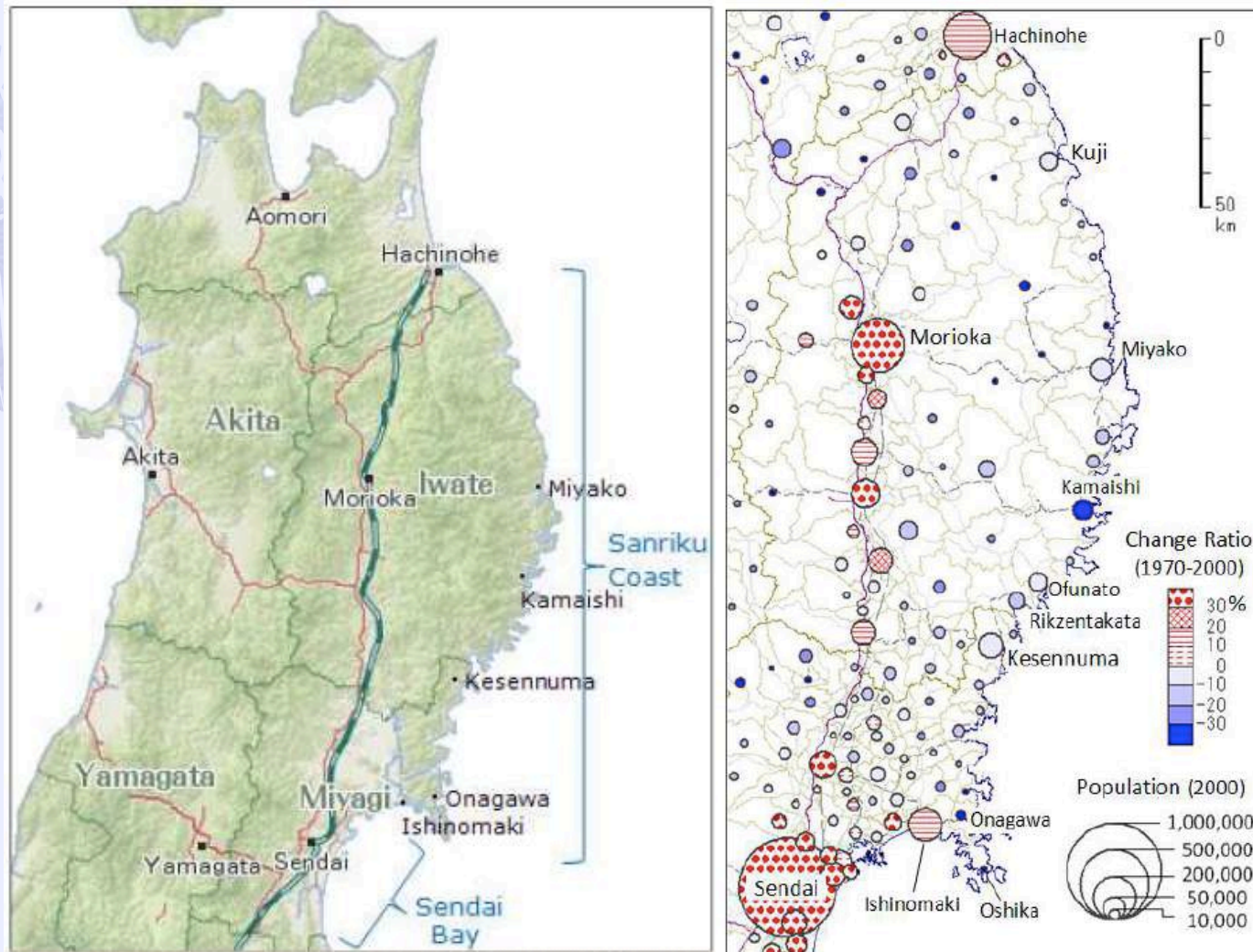
2.2 无畏（Intrepid)

The Great East Japan Earthquake

Kesennuma
City

1000km

3. 12 Kesennuma City

3. 11Kesennuma City

Levee plan by government

Population has been decreasing since 1970s in Tohoku and Sanriku Costal Area

source: National Population Census

- Sanriku Coast concentrated in some towns or cities which have major fishing ports.
- Population density is totally lower in comparison with the inland area.
- Since 1970's, the population turned to decrease owing mainly to the reduction of far-sea fishery.
- Population of the most of municipalities decreased from 1970 to 2000, while it increased in 8.7% totally in Tohoku Region.

Industrial Structure of the Area, highly urbanized

全国	4.8	26.1

1st sector   2nd sector   3rd sector   Others
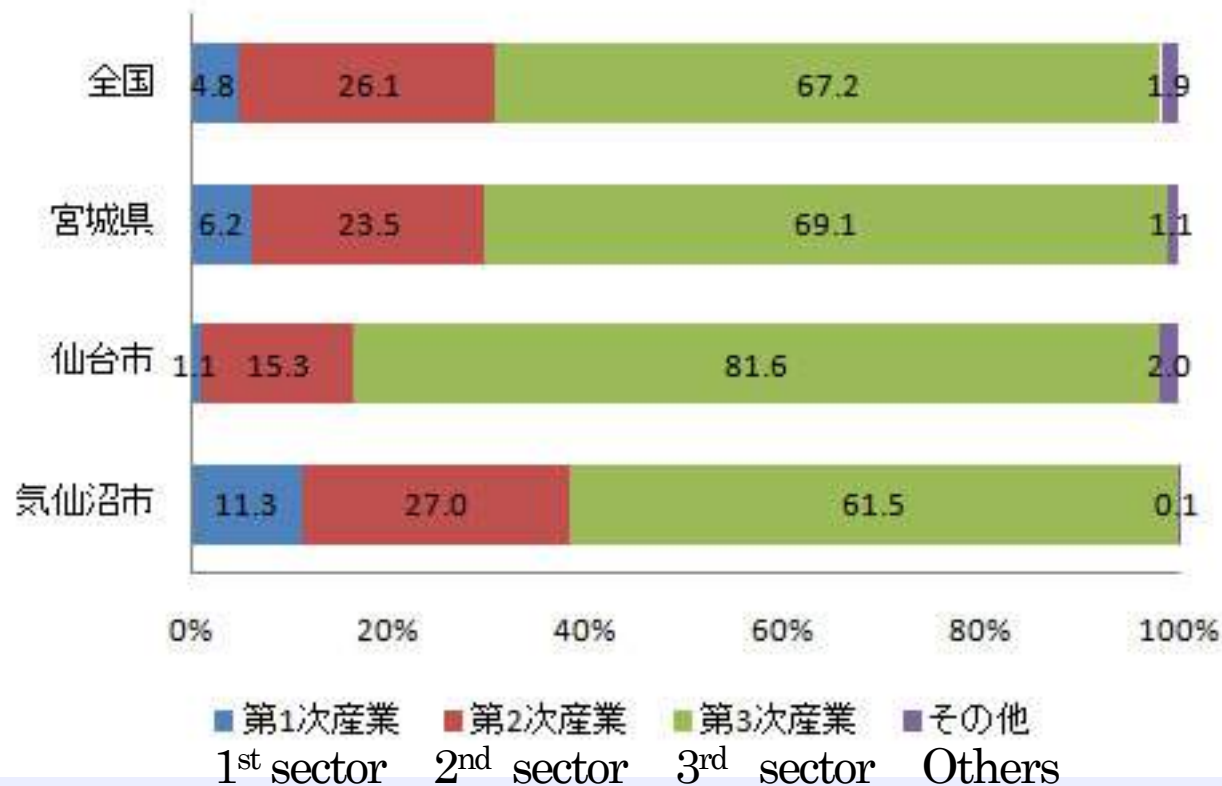
Only 11.3% of labor population is working at first industrial sector.
Source: National census agency.

http://www.buildcon.arch.t.u-tokyo.ac.jp/shinsai/html/miyagi_shikuchoson/kesennuma/sangyo.html

http://www.izcc.tohoku-gakuin.ac.jp/liberal/Ttakano/kenkyu/sanriku2008census.pdf
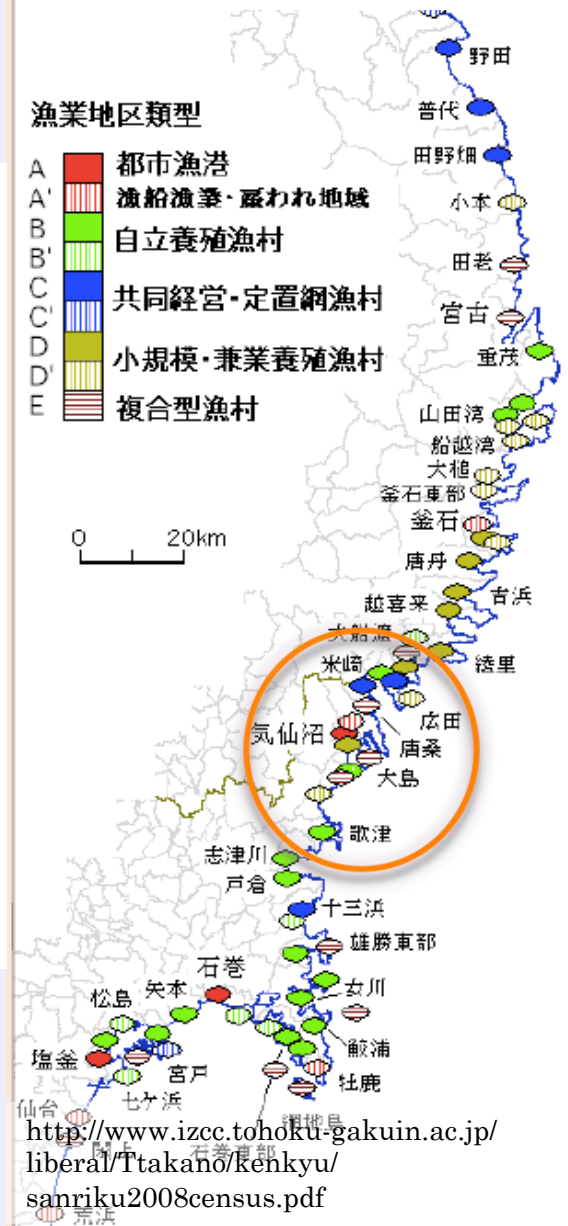
Lessons learnt from this story

- Who adapt for whom?
  - Nature is changing. Society is changing, too.
- Not engineering adaptation, resilient adaptation must be considered.
- Top down allocated budget tends to cause maladaptation.
- The main barriers are lack of communications among stakeholders, and lack of leadership at community.
- Because of uncertainty, risk, and responsibility?

2.3 无助（Hapless）

福島県放射能測定マップ
Fukushima prefecture radioactivity measurement map

空間線量率測定結果 Results of measurement of air dose rates	放射性物質測定結果 Results of measurement of radioactive material	走行サーベイ測定結果 Results of measurement of air dose rates using monitoring cars	地図から検索 Search from a Map	🔍

空間線量率測定結果の検索 Search for results of measurement of air dose rates	各地の定時測定 Measurement of fixed time observation points	学校・児童福祉施設等 Schools and Child Welfare Facilities	その他の調査 Others

福島県全域 Monitoring over the whole area of Fukushima prefecture	県北地方 Ken-poku District	県中地方 Ken-chu District	県南地方 Ken-nan District	会津地方 Aizu District	南会津地方 Minami-Aizu District	相双地方 Soso District	いわき地方 Iwaki District

地図　航空写真

全国調査結果

宮城県
0.02
マイクロシーベルト / 時

秋田県
0.04
マイクロシーベルト / 時

山形県
0.04
マイクロシーベルト / 時

茨城県
0.13
マイクロシーベルト / 時

栃木県
0.04
マイクロシーベルト / 時

※測定数値は、各都道府県の主要箇所の数値を表示しています。
※表示しているデータは、原子力規制庁で測定している測定結果です。

地図データ ©2014 Google, ZENRIN　　10 km　　利用規約
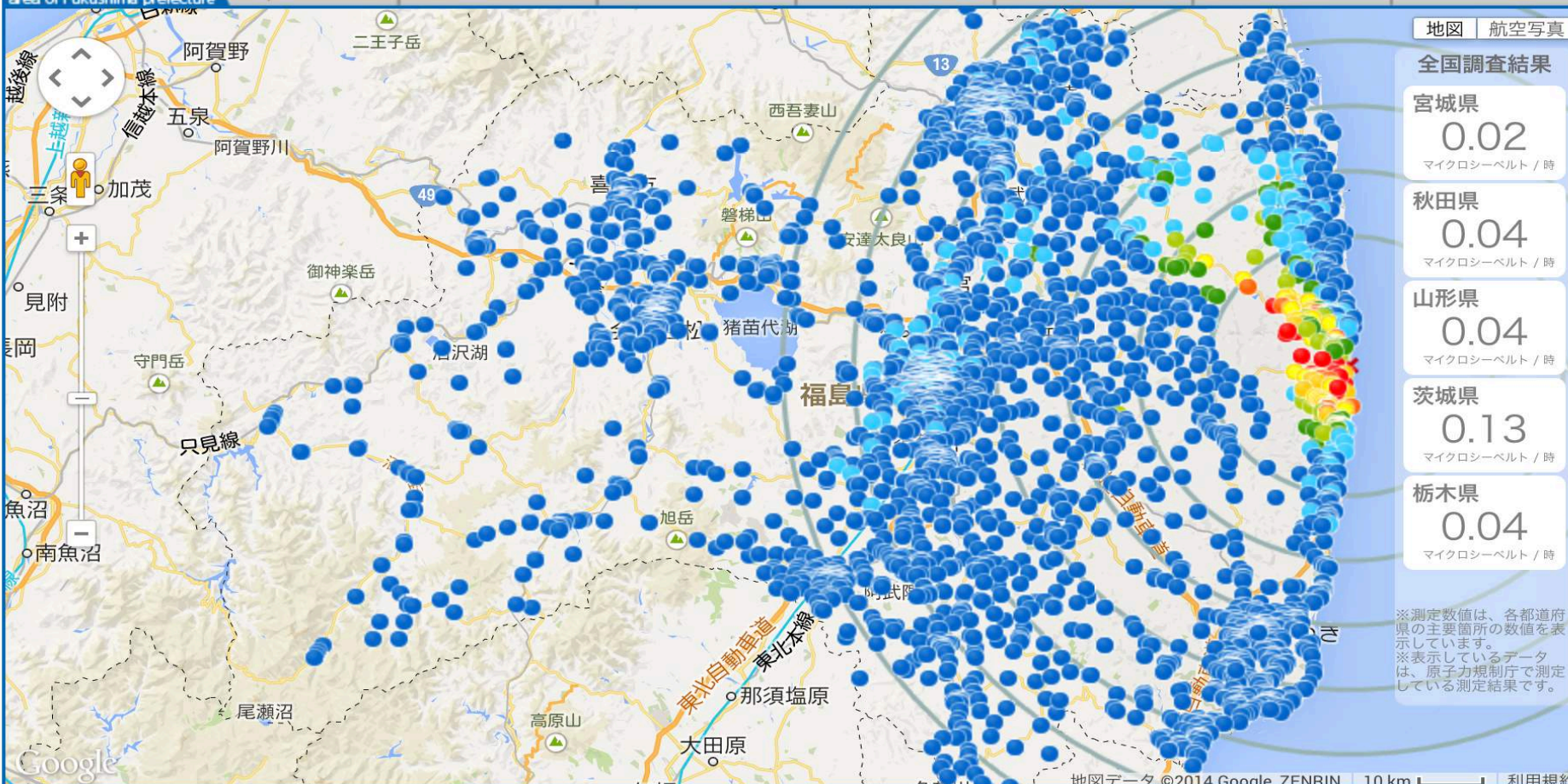
表示期間 Period	2014年… ▼	距離表示 Distance	ON	言語選択 Select Language	日本語 ▼	単位：μSv/h Unit	～0.25	～0.50	～1.00	～2.00	～3.00	～4.00	～5.00	5.01～

福岛核电放射性污染地区的问题

①对于放射性污染，学者，政府，居民，人类本身还只有非常有限的知识和信息
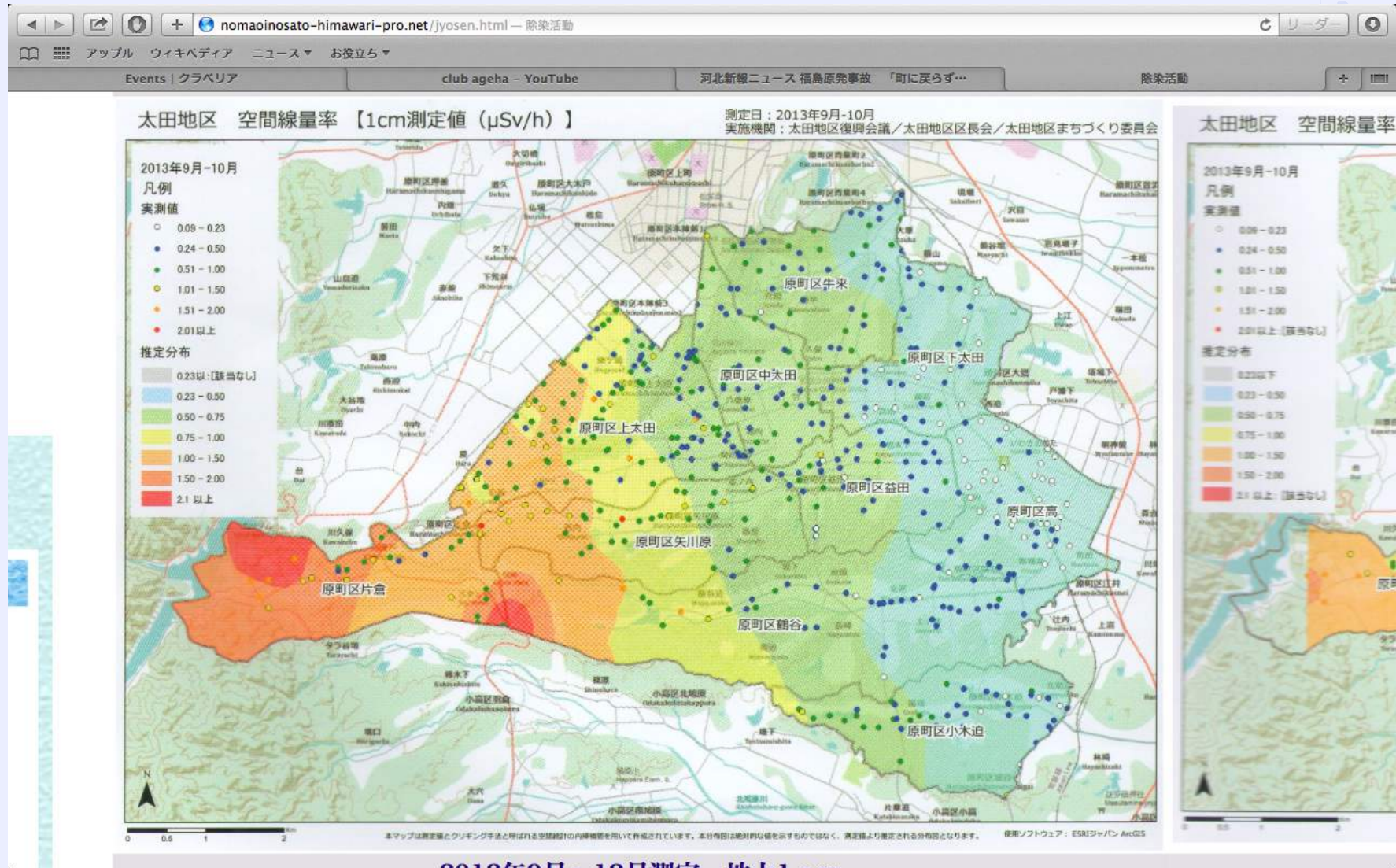
福岛核电放射性污染地区的问题

②工程去污，有些效果，只是表面。森林，土壤，地下水等的影响和去污，未知多多。

○ 既に確立してきた除染技術に加えて、
  ・ 農地については、①反転耕が難しい農地の除染、②除去した汚染土壌の減容化、③高線量地域の農地の除染
  ・ 森林については、①森林内や渓流水における放射性物質の挙動把握、②放射性物質を拡散防止・低減する手法
  等を開発する。
○ 「農林水産研究における原発事故への対応方針」を策定・公表するとともに（３月１２日農林水産技術会議決定予定）、この方針の実現に中心的な役割を果たす（独）農研機構の中期目標の変更及び指示並びに中期計画の変更認可を行い（３月中）、今後とも、これらの技術開発等を着実に推進。

農 地

①水等で土壌を撹拌し、放射性セシウムを吸着した粘土粒子を効率的に除去。

サクションホース　バキューマー

②汚染農地土壌から放射性セシウムを分離・除去。

乾式セシウム除去技術の実証試験では、放射性セシウムを99％以上除去。（平成24年2月22日公表）
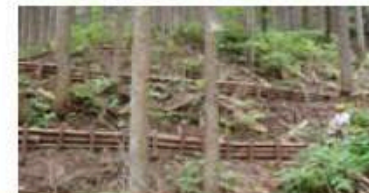
③高線量地域において、効率的かつ安全に農地の除染を行う機械・技術を開発。

粉じん侵入防止
放射線の遮蔽　Cs　Cs
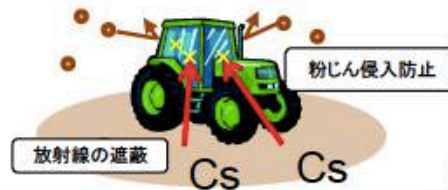
森 林

①土壌や樹木、渓流水などに含まれる放射性セシウムの挙動を把握。

雨量・流量の観測
濃度の計測
流出水、浮遊土砂の採取

②立木の伐採等が、林内の空間線量率等に与える影響や、木柵などの設置による土壌の移動抑制の効果を検証。

http://www.maff.go.jp/j/kanbo/kihyo02/godo/pdf/2-8_jyosen.pdf

福島核电放射性污染地区的问题

③受灾地区的人口、雇用、医療、農業、保健、損失補償等，问题成山。非常复杂。

○人口について

震災前の**71，561人**から**64，368人**に減少（H25.6.1住民基本台帳）

○避難等の状況について（H25.5末現在南相馬市避難者情報及びH25.4南相馬市教育委員会調べ）

◆市外避難者：**16，138人**（約22%）

◆市内避難者（津波被災者含む）：**11，254人**（約15%）

◆転出者：**6，411人**（約9%）

◆市内居住者：**46，512人**（約65%）

◆子育て世代（20〜39歳）の**約44%**が市外へ避難

◆小中学校の児童生徒数は**約54%**に減少

◆保育園・幼稚園の児童数は**約40%**に減少

※「○○%」はすべて事故前の人口、生徒・児童数に対する割合

若い世代の流出が復興のスピードを減速させる

○避難者の帰還意向について（H24.8旧警戒区域及び旧計画的避難区域の市民を対象とした意向調査）
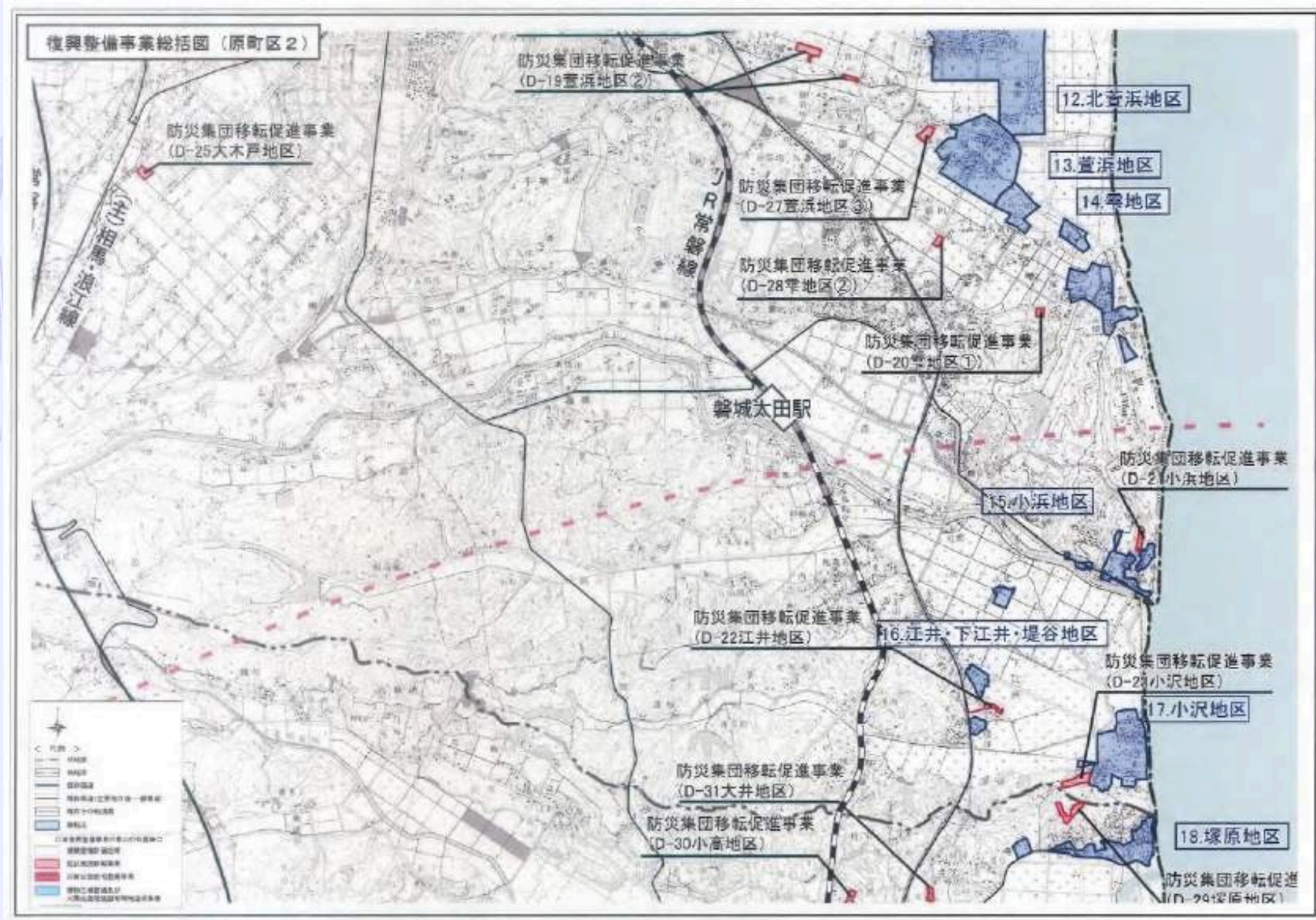
◆「戻りたい」**43%**

◆「戻りたくない・戻らない」**21%**

◆「現在は未定（悩んでいるなど）」34%

戻るための条件

①「事故の収束」
②「線量の低下」
③「十分な賠償」
④「福祉・医療サービスの再開」

福岛核电放射性污染地区的问题

④政府，市民制定了的重建规划。但是核污染问题不解决，实施无从谈起。

http://www.city.minamisoma.lg.jp/index.cfm/10,208,c,html/208/20130412-085203.pdf

灾后重建的目标：
使受灾地区／受灾者恢复"平常"

◆ 平常 ● 受灾

● 新的平常

地震
海啸
核电

目标和远景在哪里？

将是漫长的过程

希望尽快跳出不幸的状态

Lessons learnt from this story

- The Earth and Society are Complex Systems
- Our interventions in the environment are based on a simplified vision of it. No experts exist, nothing is certain. There exist side-effects, unintended consequences of our decisions.
- Human perception has limits. **The more we think we know, the less we know.** Risks inherent in the sciences themselves.
- Disaster could be a window of opportunity for adapting to and transforming to a new arena.

3. 弹性思考的理论

灾害的基本对策

- 预防:
  - Precautionary Principle
- 防灾:
  - Disaster Prevention
- 救灾:
  - Relief
- 恢复:
  - Recover
- 重建:
  - Reconstruction

传统的防灾

- ◆ 重救灾，轻防灾
- ◆ 重防止，轻预防
- ◆ 重短期，轻长期
- ◆ 重技术，轻社会
- ◆ 重恢复，轻转型

减灾的思路

- ◆ 减灾思路认为灾害不可能完全预知，防止。重在综合预防，风险管理，以求减少损失。
- ◆ 减灾要求综合认识灾害风险，建设弹性社会。

复杂系统的弹性概念

Threshold

Shock／外力

Resilience
弹性

Bouncing Back
复原力

Resistance
抵抗力

Stable Area
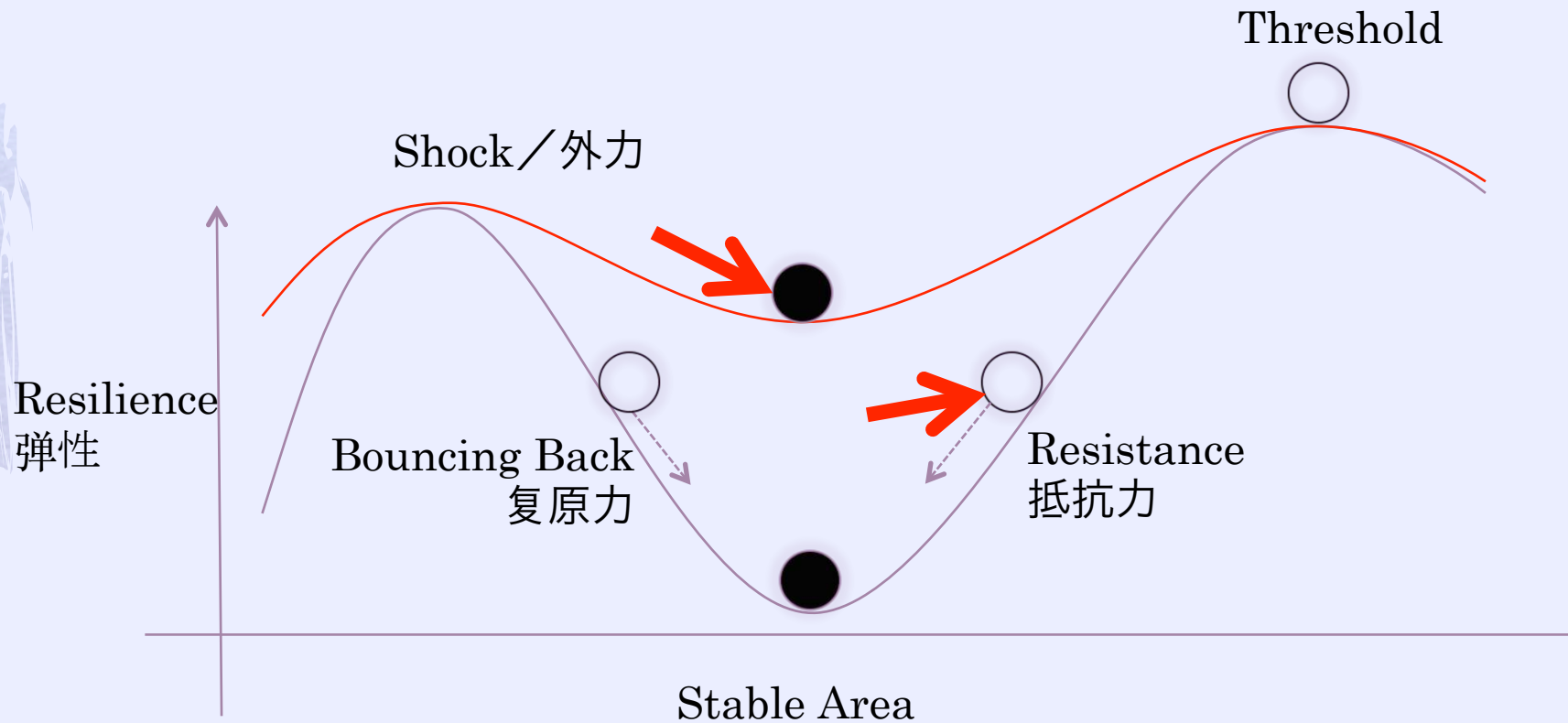
Resilience is a property of a system in Engineering, Ecology, and recently Sociology.

Resilience as property of complex systems
弹性是复杂系统的基本特性

RESILIENCE AS THE RESULT OF ABSORPTIVE, ADAPTIVE, AND TRANSFORMATIVE CAPACITIES
弹性是复杂系统的吸收变化，适应变化，结构转型的过程

弹性构建的基本框架

Intensity of change / transaction costs
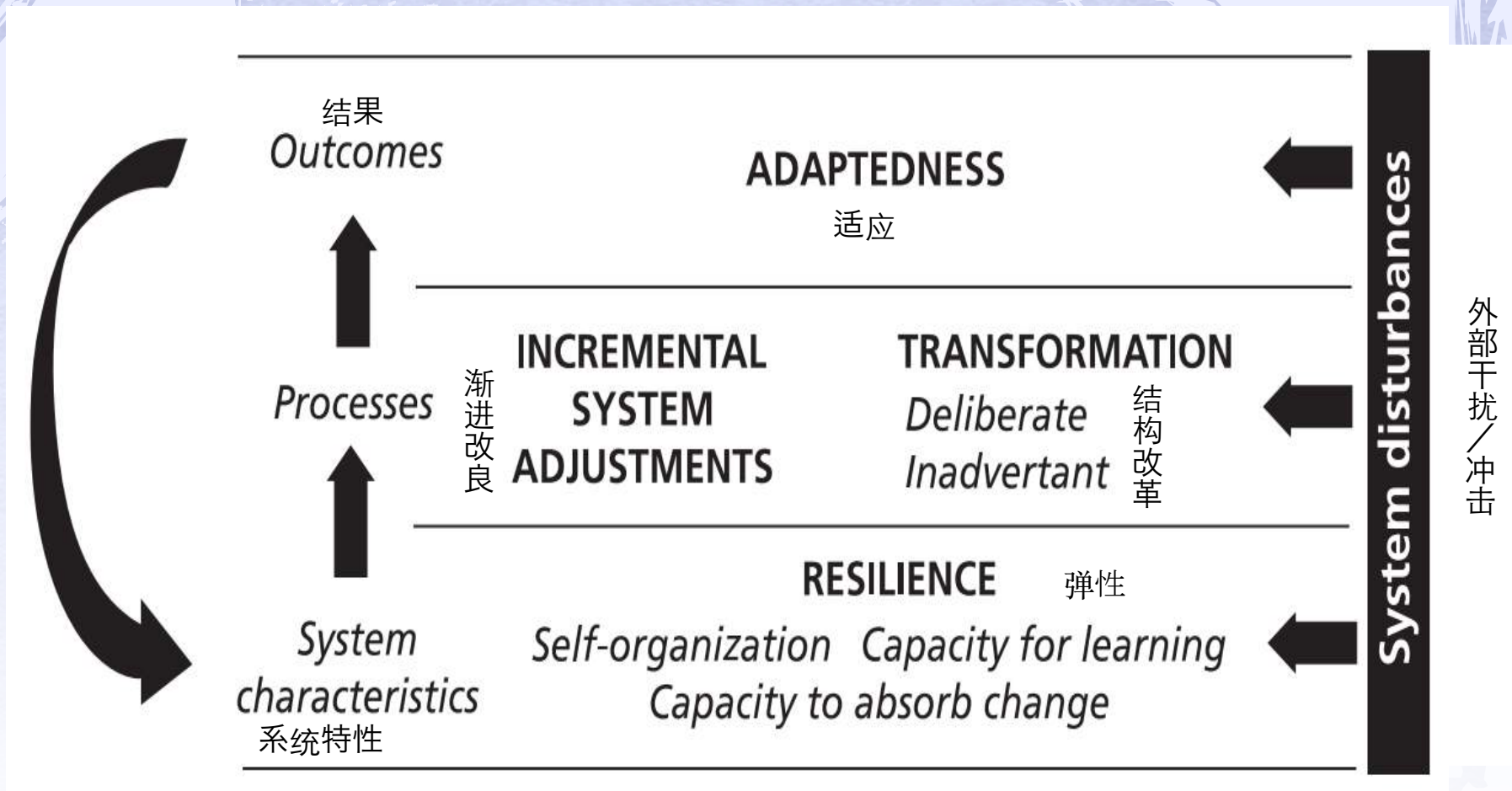
stability	flexibility	change
Coping/ rehabilitating	Adapting (incremental adjustment)	Transforming (transformational responses)

resilience

干预对策
Interventions

Short term
(reducing impact of vulnerability)

短期

预防
Protective
(ex post)

保护
Preventive
(ex ante)

促进
Promotive
(assets)

转型
Transformative
(agency)

长期

Long-term
(addressing structural causes of vulnerability)

outcomes
结果

目的
objectives

Assessment matrix
评价体系

弹性思考的核心：增长与重建的适应回路

The adaptive cycle (Holling 2001, Gunderson and Holling 2002): a useful metaphor for understanding incremental and radical innovation in complex SES. Adapted from *Panarchy* 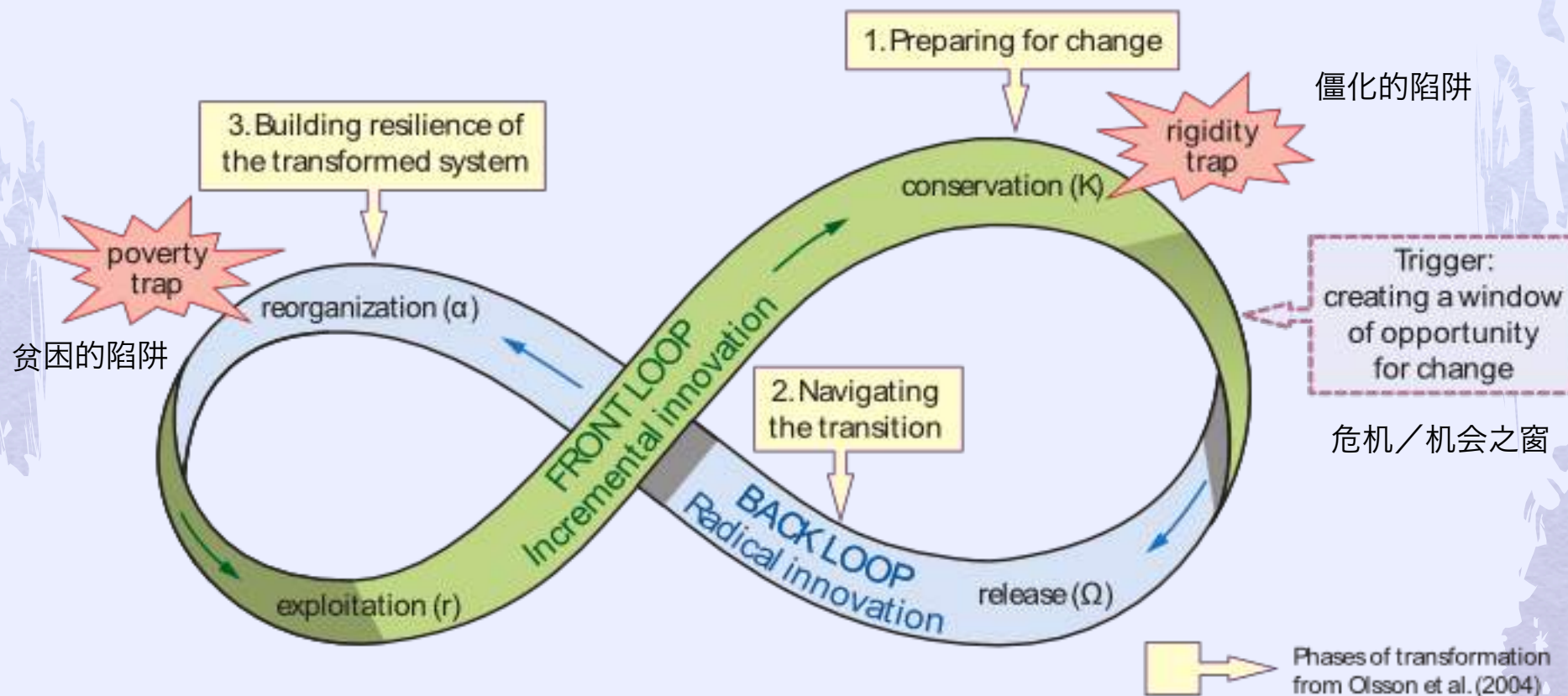by Lance H. Gunderson and C. S. Holling, editors. Copyright © 2002 Island Press. Reproduced by permission of Island Press, Washington, D.C.

僵化的陷阱

贫困的陷阱

危机／机会之窗

- 适应循坏由正面回路和回归回路构成。正面回路反映渐进改良，回归回路反映根本变革。
- "poverty trap"（贫困的陷阱）：缺乏创新，难以从回归回路中跳出。
- "rigidity trap"（僵化的陷阱）：固守成规抵制改革，导致突发变故，进入回归回路。
- 灾害／危机可能是崩溃的导火线，也可以是再生的机会之窗口。

弹性思考的概念框架

To Sustainability

Outcome	**More Resiliency**
Process	**Adaptation (Incrementally)** — **Transformation (Transformative)**
Input	
Characteristics	**Vulnerability (Current Resiliency)**

Disturbance/Change
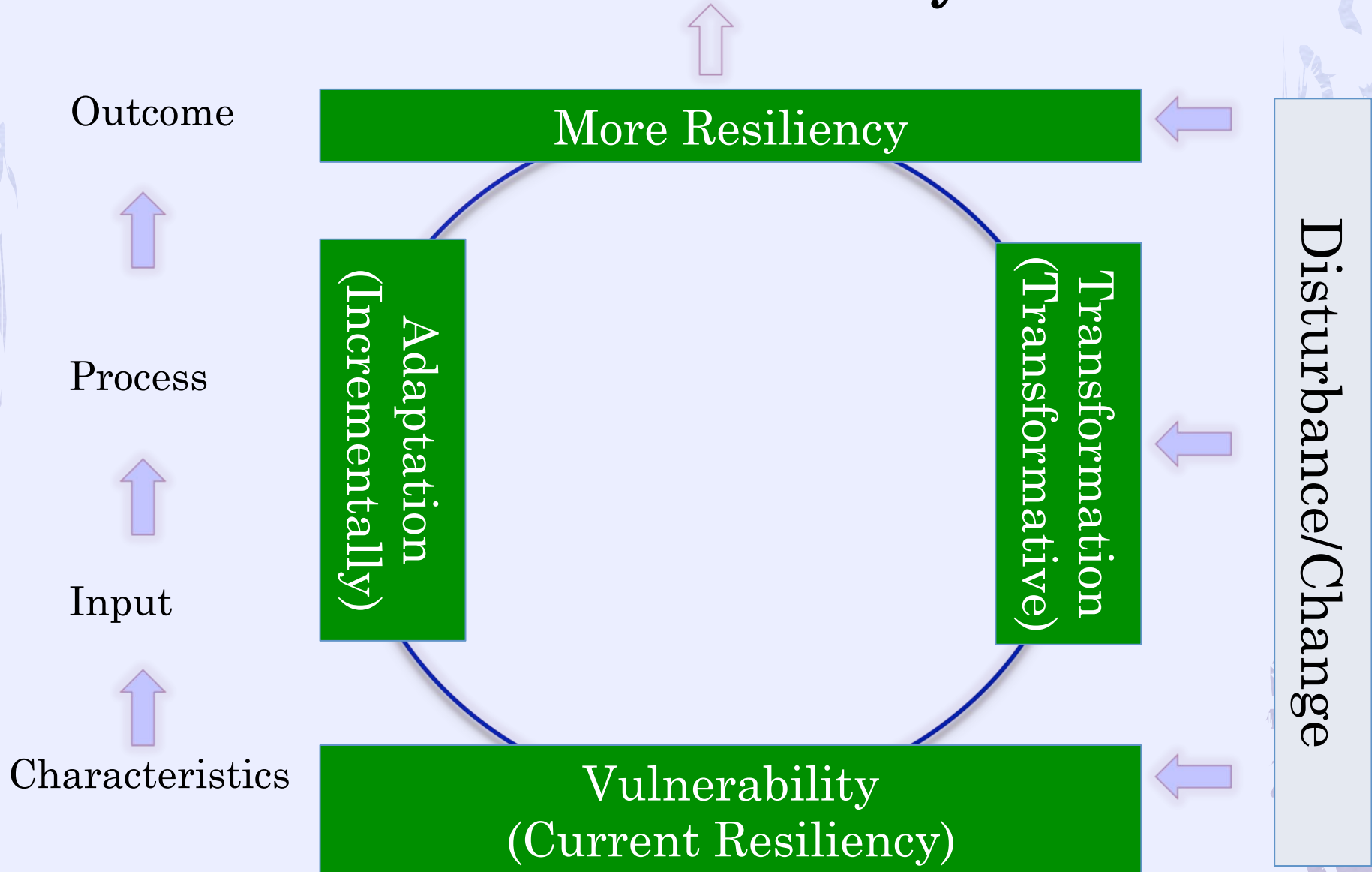
So, what is resilience?

◆ Precaution to uncertainty

◆ Window of opportunity

◆ Bridge to sustainability

◆ Approach to distribute risk

Reflexive Learning Process

Loss and Damage by Disasters could be the forces of the evolution of human society
危机／灾害可以成为人类社会前进的动力

◆ Some part of loss and damage is unavoidable because there will be always unprecedented events. We must learn to live with risk.

◆ The reduction of loss and damage must be realized by the transformation of social systems, our mindsets and our values. 防灾减灾的弹性思考的关键是社会体系的重构，思考方式，价值观的转型。

From ➡ To

From
- Over-populated
- Depopulated
- Over-centralized
- Over-industrialized

To
- Well-distributed
- Autonomous
- Self-organized
- Adaptive

Summary

- Building resilience is a process of self-learning and reorganization,

  - requiring accumulation of knowledge, on-the-ground practice, and collaborations of multiple stakeholders.

  - It relies on strong bonds across similar groups, bridges among diverse groups, and links between different levels of action.

- Building resilience requires a coordinated effort that unites governments, businesses, research organizations, academia and communities.

- Disaster is a window of transformation, enhancing resilience.

- Local and community owe assets – knowledge, know-how, trust, connections and social support systems, along with more tangible assets – play an important role in sustaining or building local capacity to be resilient.

◆ *We cannot solve our problems with the same thinking we used when we created them.*

◆ *Albert Einstein*

◆ *We can bring the best parts forward into our best future. But only if we see how thoroughly our world differs from the past.*

◆ *Douglas K. Smith, "On value and values"*