

Risk Governance

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Abstract

A number of topics related to risk analysis are introduced and discussed. First, we discuss the idea, methodology and features of “risk” and “governance”. Then, a brief overview of the methods of chemical risk assessment is introduced. Each step is presented using a Toluene case study. In order to manage risks efficiently, socio-economic analysis plays some role in risk management. In addition, risk tradeoff should be carefully considered in decision-making. We show various examples of risk-risk tradeoffs. We also introduce the concept of risk perception, which is important in considering the social acceptance of emerging technologies. Finally, the roles of each player in society are summarized to achieve good risk governance.



APEC Seminar Dec. 5 2007

Risk Governance

AIST CRM
KISHIMOTO, Atsuo
(Ph.D. Economics)
December 5 2007

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Structure of Talk


- Risk
- Governance
- Risk Assessment
- Risk Management
- Risk Trade-Off
- Risk Perception
- Good risk governance

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Risk

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Two Types of Risk

- Financial risk
- Physical risk
 - Human health risk
 - Ecological risk


} Today's topic

How can we distinguish between the two?

When you travel by plane,
 A) Buy insurance.
 B) Choose safer airline.

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Why "Risk" ?

- **We must distinguish between "Hazard" and "Risk".**
- **Dioxins are said to be extremely-poisonous, but when exposure level is very low, there is little or no risk.**
- **We consume salt in every meal, but when we eat too much, there is significant health risk.**
- **In order to manage something, we must act according to the level of risk, not its hazard.**

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Why "Risk" ?

- **Paracelsus (1493- 1541)**

"All things are poison and nothing is without poison, only the dose permits something not to be poisonous."



<http://en.wikipedia.org/wiki/Paracelsus>

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Risk = Hazard × Probability


hazardous property
Incidence rate (accident, epidemics)
Exposure level (chemicals)

All we want is reducing **total risk**.

- Individual risk = Severity × Probability
(in case of death, the death rate)
- Population risk = Individual risk
× Exposed Population


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Risk and Benefit

- Risk and benefit are two sides of the same coin.
- Something has risk because it may bring benefit.
- It means that **it costs to reduce risks.**



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Priority Setting

- Both the national and household budget have a finite amount of money and human resources.
- Therefore, we must set priority in reducing risks.
- Pursuit of **“zero risk”** is impossible and rather harmful, because we must give up some more effective life-saving options.


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Governance

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Governance

- United Nations Economic and Social Commission for Asia and the Pacific's Definition

“the process of decision-making and the process by which decisions are implemented (or not implemented).
Governance can be used in several contexts such as corporate governance, international governance, national governance and local governance. . . . Government is one of the actors in governance. ”

<http://www.unescap.org/pdd/prs/ProjectActivities/Ongoing/gg/governance.asp>

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Governance

- European Union's definition
 “the term "European governance" refers to the rules, processes and behaviour that affect the way in which powers are exercised at European level, particularly as regards *openness, participation, accountability, effectiveness and coherence.*”
- Five “Principles of Good Governance”

http://ec.europa.eu/governance/index_en.htm

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From Government to Governance

- ⇔ top down legislative approach
- As a joint effort of *public, industrial, and civil society actors.*

Government model

➔

Governance model

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Why “Governance” ?

Three challenges of risk management

- **Complexity** in assessing causal and temporal relationships
- **Uncertainty**
 - Variation among individual targets
 - Measurement and inferential errors
 - Genuine stochastic relationships
 - System boundaries and ignorance
- **Ambiguity** in interpreting results
 - Interpretative ambiguity (What does it mean?)
 - Normative ambiguity (Is it tolerable?)

Ortwin Renn (2006). Risk Governance: Towards an Integrative Framework.


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Risk Governance: Nanotechnology Case

- **Government:** laws and regulations, certification
- **Industry:** voluntary standards, proactive risk assessment, information disclosure.
- **Scientists/Researchers:** risk research, enlightenment, communication
- **NGOs:** participation, collaboration with industry
- **Public:** public involvement/participation, freedom-of-information request, product purchasing (or not)


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Risk Assessment

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Risk Assessment and Management

Risk Assessment

Hazard Identification
 (Does the agent cause the adverse effect?)

↓

Dose-Response Assessment
 (What is the relationship between dose and incidence in humans?)

↓

Exposure Assessment
 (What exposures are currently experienced or anticipated under different conditions?)

Risk Management

Development of regulatory options

↓

Evaluation of public health, economic, social, political consequences of regulatory options

Risk Characterization
 (What is the estimated incidence of the adverse effect in a given population)

Agency decisions and actions

U.S. National Research Council (1983). Risk Assessment in the Government: Managing the Process.

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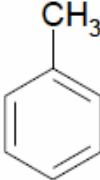
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higher than outdoor toluene concentrations in most cases.


Risk Assessment: Toluene Case

Toluene is a chemical substance whose release to the atmosphere is the largest among 354 chemical substances reported by PRTR (Pollutant Release and Transfer Registers) system in Japan.

At the same time, toluene is also known as one of the major indoor air pollutants and the guidance value was set by then Ministry of Health and Welfare in 2001, although it is non-binding. In almost cases, indoor toluene concentrations are substantially higher than outdoor toluene concentrations.



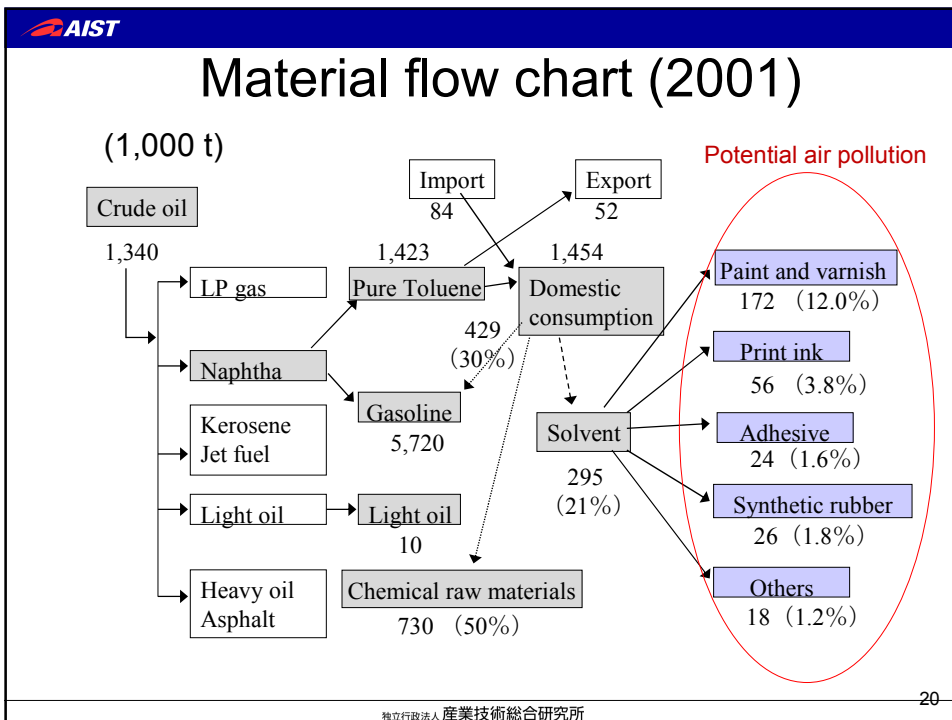
Risk Assessment Document

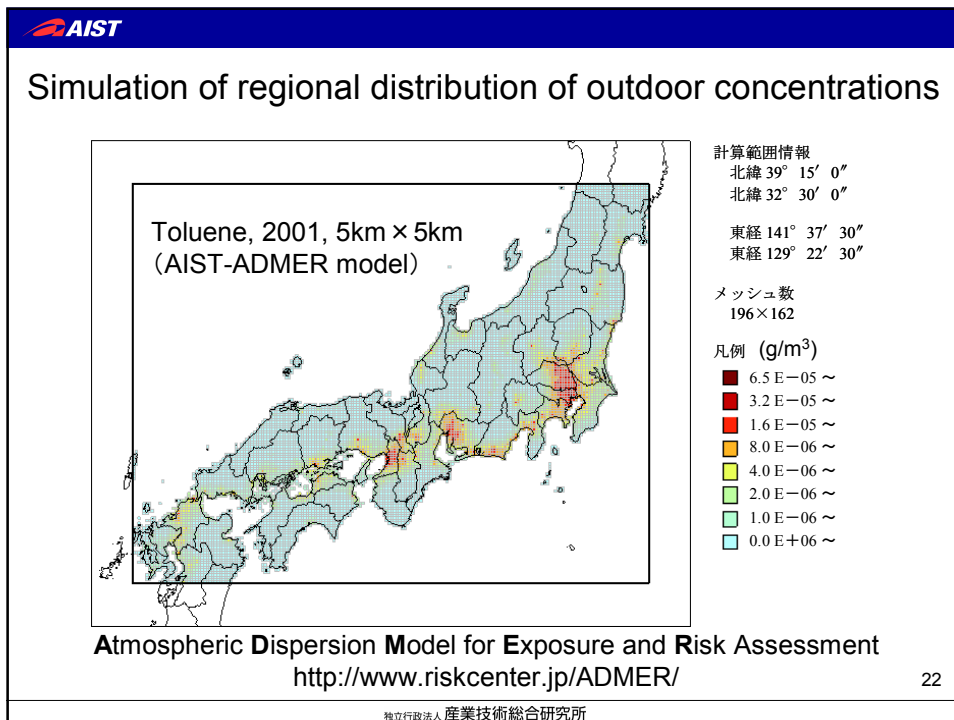
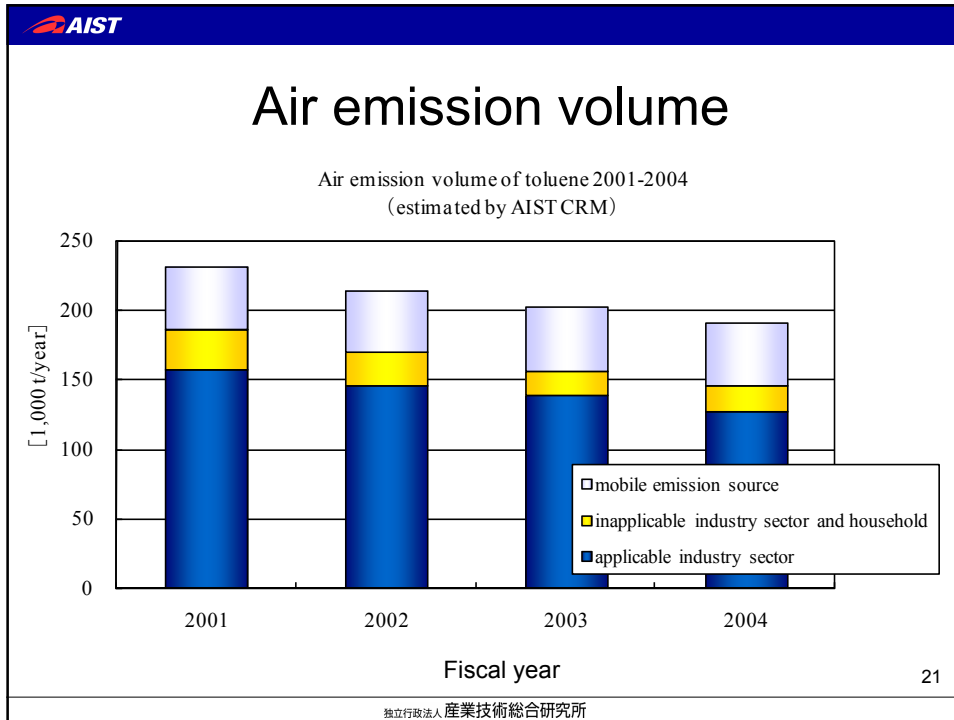


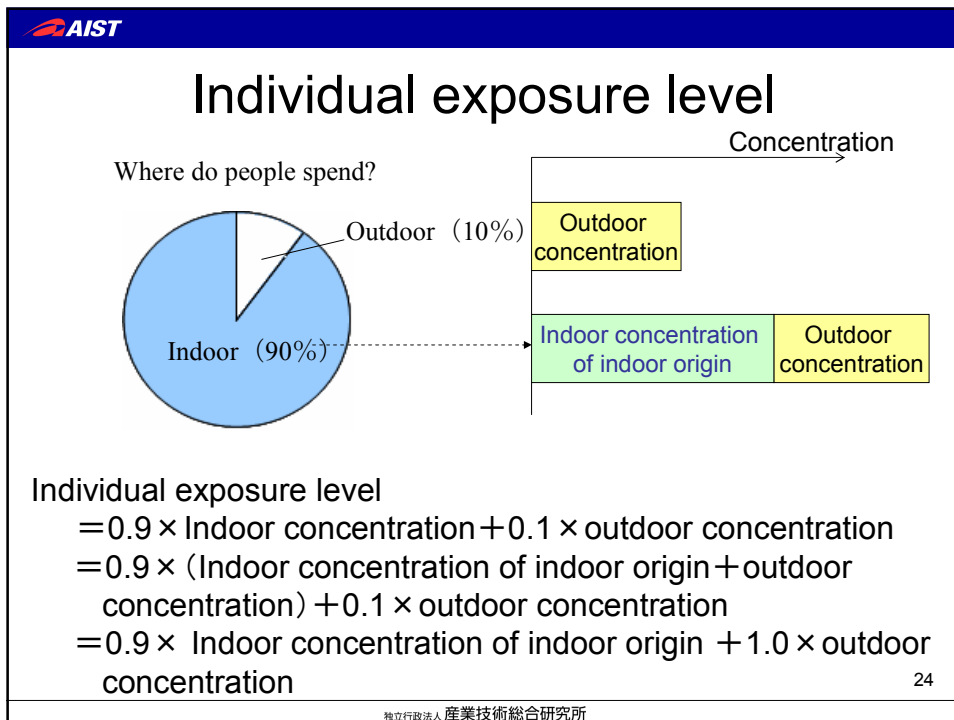
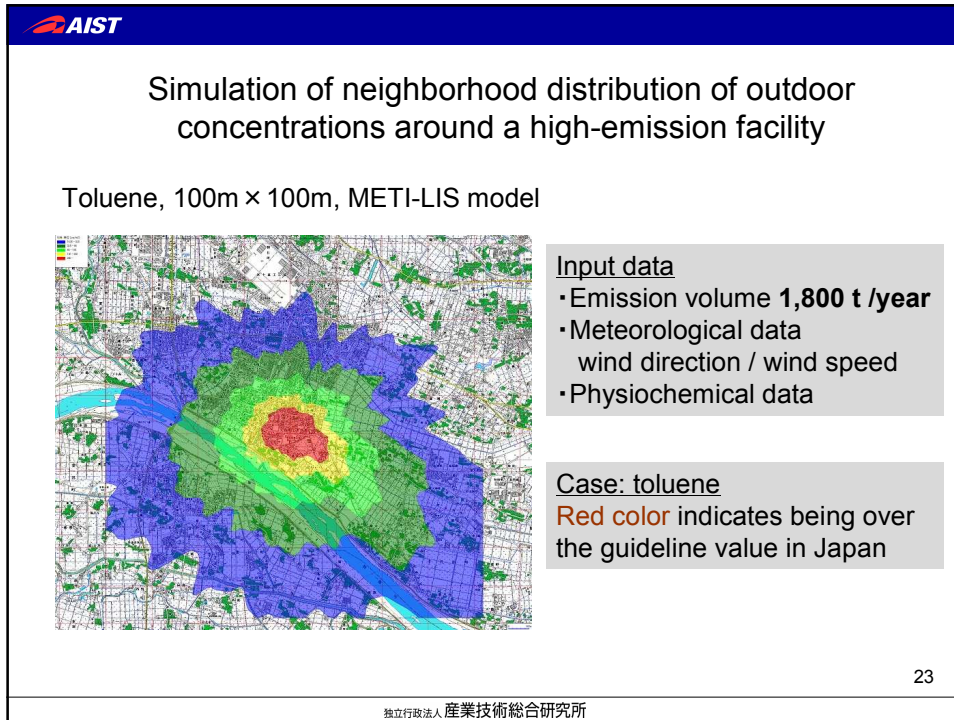
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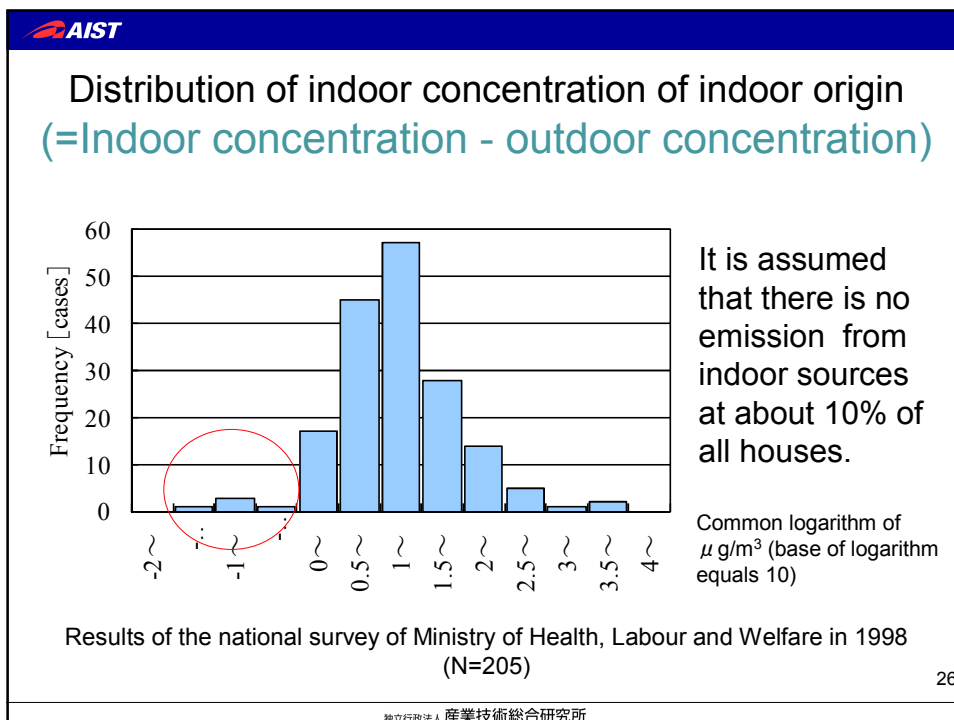
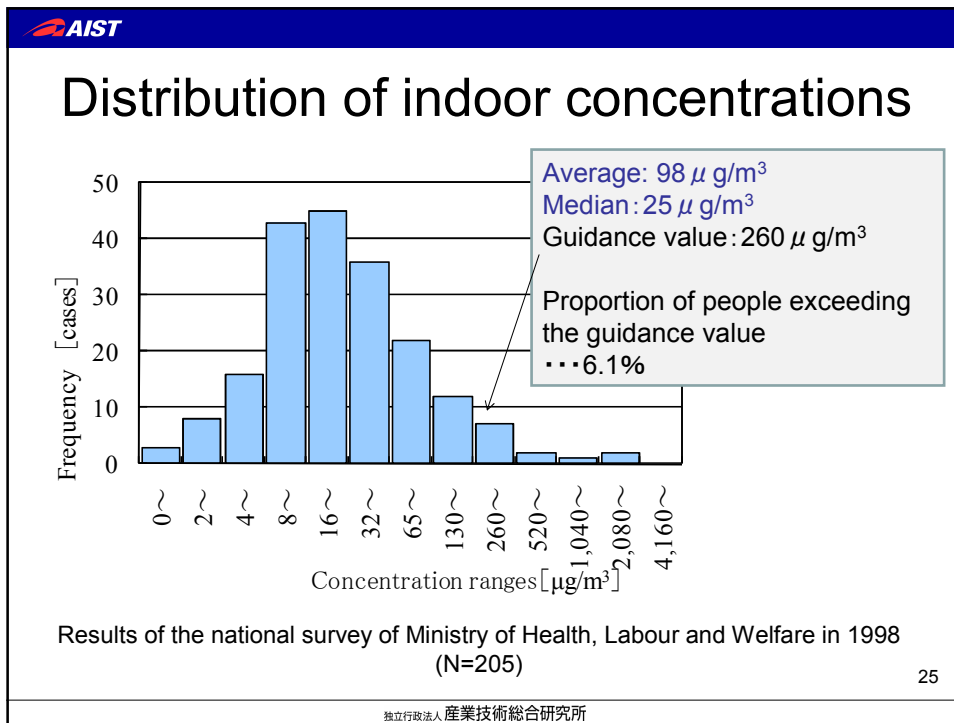
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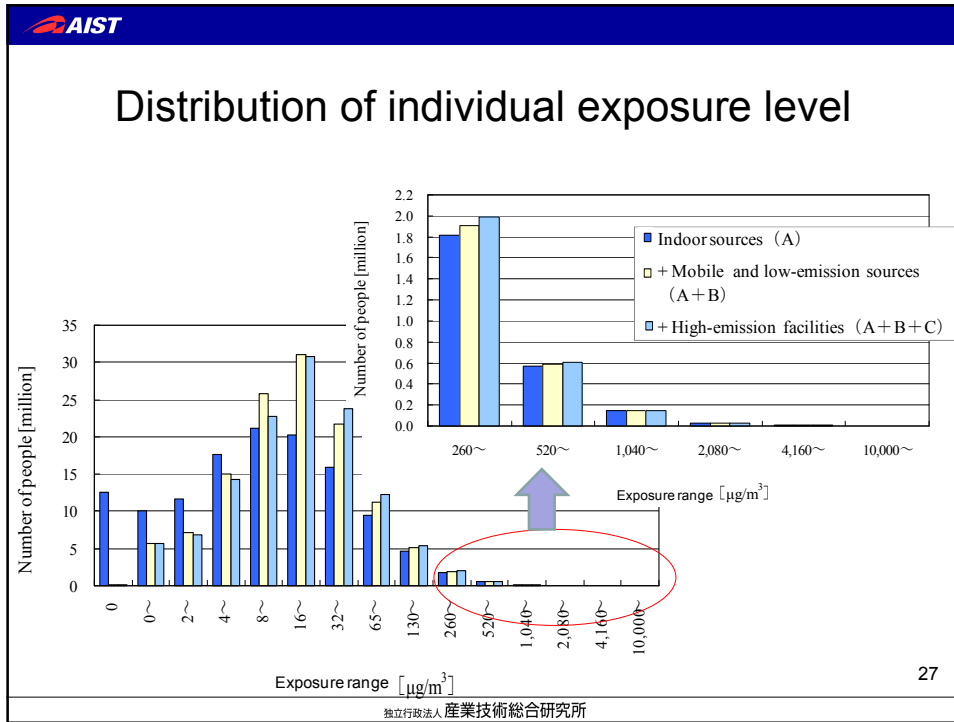
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Risk Management

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Framework for Environmental Health Risk Management

- Define the **problem** and put it in **context**.
- Analyze the **risks** associated with the problem in context.
- Examine **options** for addressing the risks.
- Make **decisions** about which options to implement.
- Take **actions** to implement the decisions.
- Conduct an **evaluation** of the action's results.

Source: The Presidential/Congressional Commission on Risk Assessment and Risk Management (1997). Framework for Environmental Health Risk Management.

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Annual Fatalities in Japan: 1 million

If the whole GDP is spent on saving these lives...

Category	Number of Fatalities
malignant neoplasm	309,465
cardiovascular disease	159,406
cerebrovascular disease	132,044
pneumonia	94,900
accidental death	38,688
suicide	32,082
die of "old age"	23,446
kidney failure	18,797
liver disease	15,729
COPD (chronic obstructive lung disease)	13,617
Others	176,860

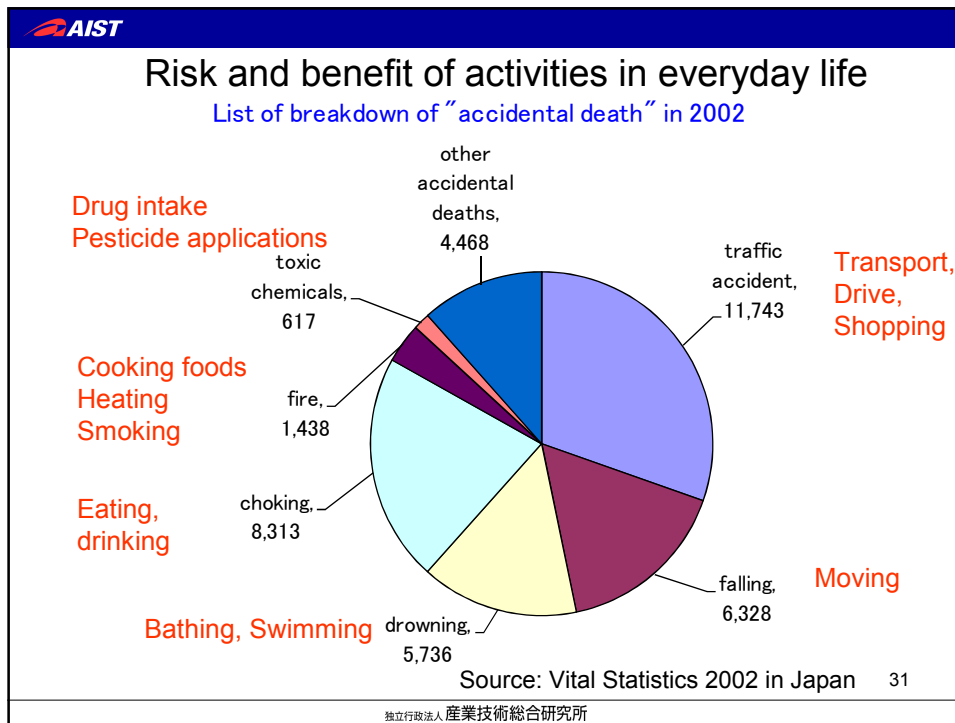
GDP in Japan is about 500 trillion yen.

500 trillion yen ÷ 1 million fatalities = 500 million yen

However, we must spend money other than saving lives, such as foods, cloths, leisure, etc.

Source: Vital statistics 2002 in Japan

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Two ways to reduce risks

- 1) Spend money
- 2) Give up benefits

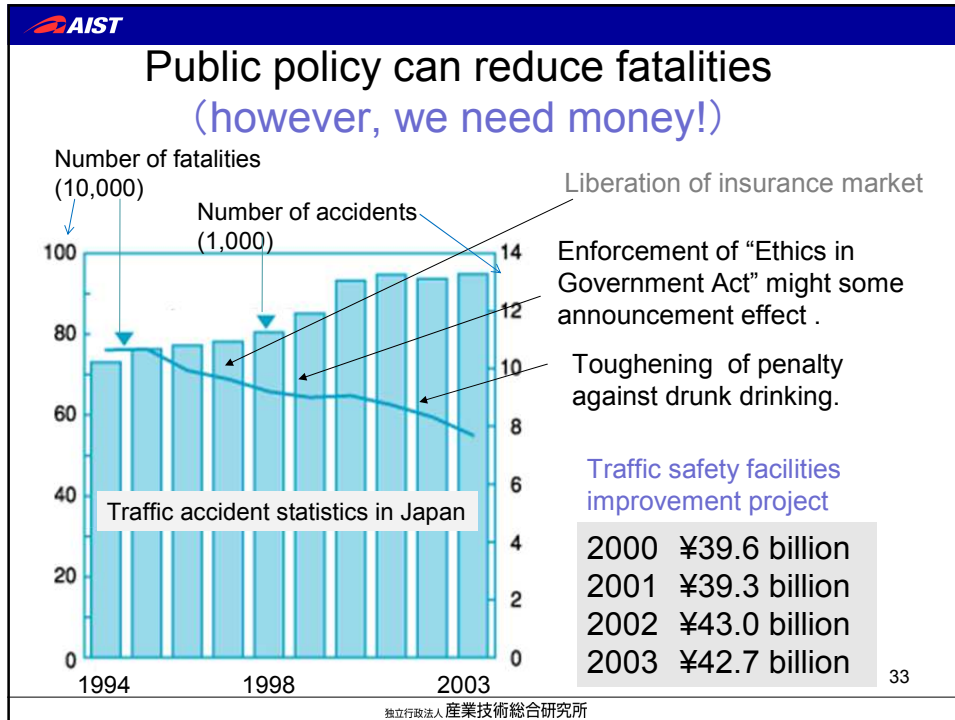
In case of traffic accident

- 1) Equip air-bags, install guardrail
- 2) Strengthen speed limit

Restrict inflow of automobiles

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Socio-Economic Analysis / Regulatory Impact Assessment

For policies, programs, regulations, countermeasures, etc. to reduce health risks

- 1) List all possible consequences
- 2) Express them quantitatively
- 3) Monetize them if possible
- 4) Summarize them into "cost-effectiveness analysis" or "cost benefit analysis"

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Role of Socio-Economic Analysis

For individuals, organizations, society,

- Setting priority on risk reduction measures (relative assessment)
→ cost-effectiveness analysis (CEA)
- Is this measure beneficial ? (absolute assessment)
→ cost benefit analysis (CBA)

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Cost Effectiveness Analysis (CEA)

to maximize health benefits attainable within a specific limited budget

to minimize total cost while predetermined health benefits are achieved



$$\frac{\text{Cost (¥)}}{\text{Effectiveness}}$$

Prioritize the smallest C/E !

- Cost per cancer avoided (cost of mass screening ÷ reduced cancer incident)
- Cost per traffic accident avoided (cost of traffic light ÷ reduced accident)
- Cost per baseball team victory (Annual pay ÷ victories)

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Cost Benefit Analysis (CBA)

Monetize “effectiveness” → “benefit” (¥)

$$\textit{Benefit} - \textit{Cost} = \textit{Net Benefit}$$

When Net Benefit > 0 ... we gain.
When Net Benefit < 0 ... we lose.



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Case 1

Emission of Benzene from a chemical plant

→ Cancer risk to local community

→ (Saving in investment of anti-pollutant measures = benefits)



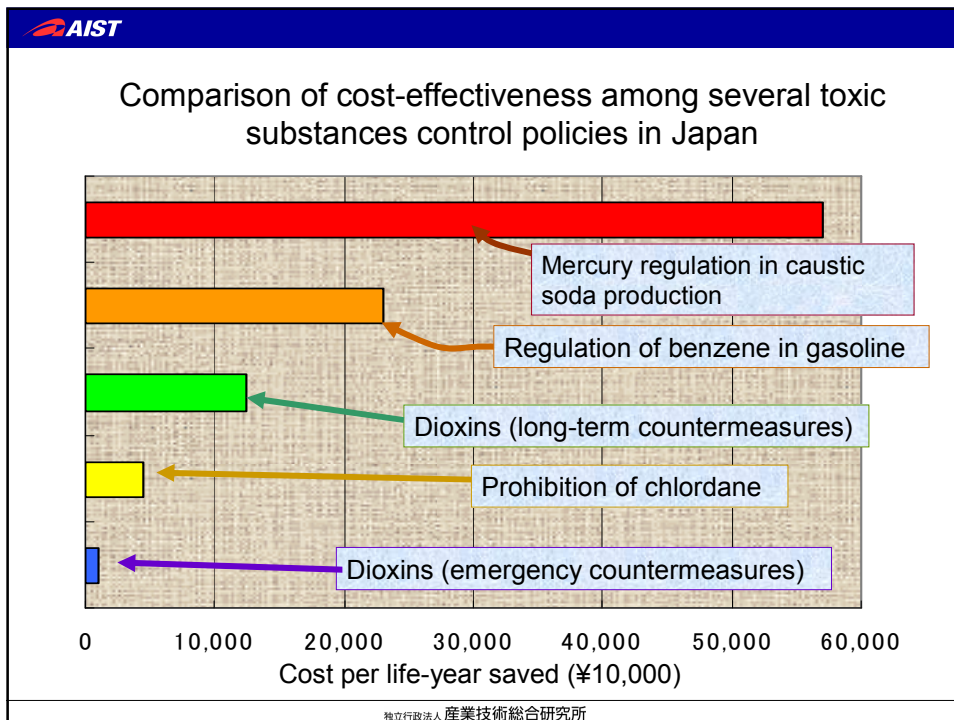
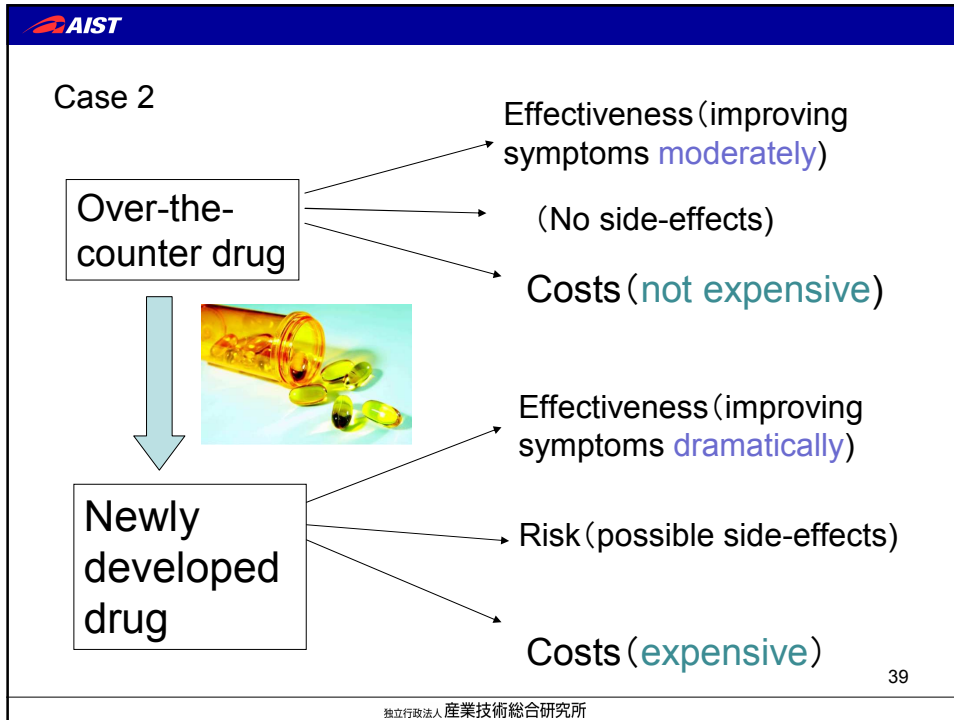
Installment of activated carbon adsorption equipment

→ Reduction of cancer risk = “effectiveness”

→ Burden of Investment and operating costs

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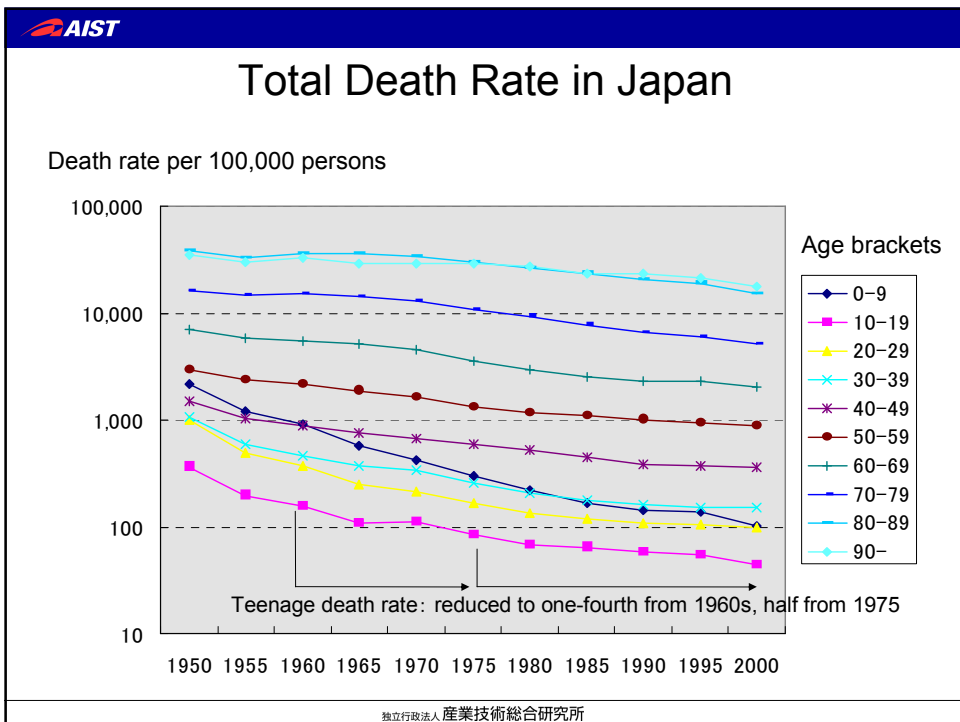


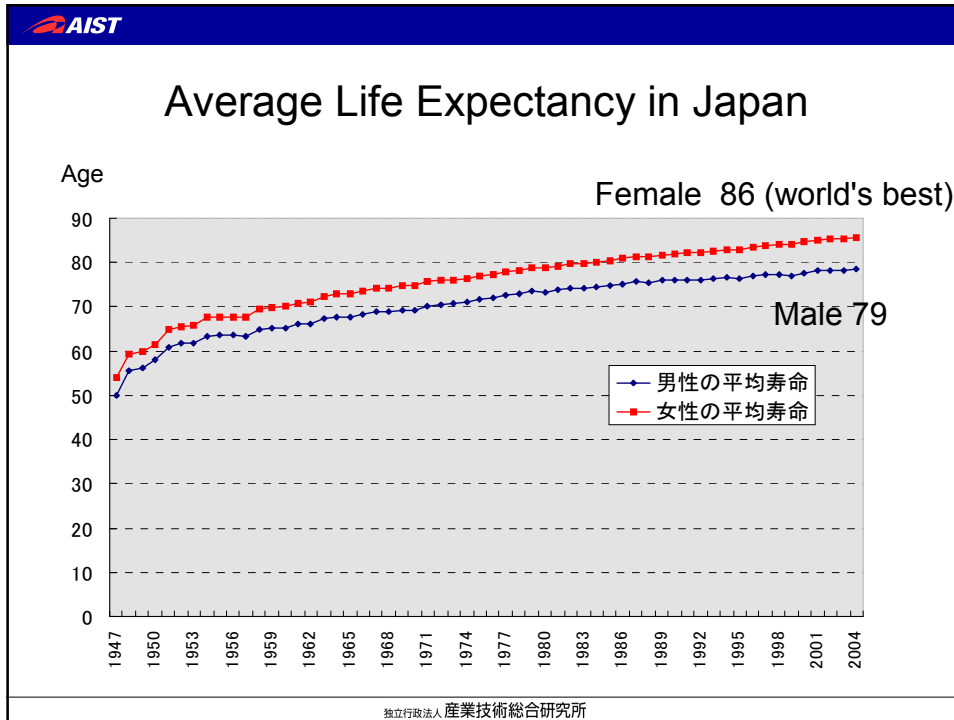
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Risk Trade-Off

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Risk Management in the age of “multiple risks”

Each risk level becomes low, but . . .

- We are facing “multiple” risks simultaneously.
- People demand even lower risk level than before.

Therefore, we need to think about the larger picture. We must see the forest for the trees.



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Topics to debate

- How safe is safe enough?
- How can we consider individual variability
- Is “zero risk” achievable?
- Not only quantity, but also quality of risk?
- Objective risk or subjective risk?


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Do seatbelts increase the number of accidents?

Peltzman (1975) insisted that safety regulations of automobiles by the federal government did not reduce the number of fatalities of traffic accidents.

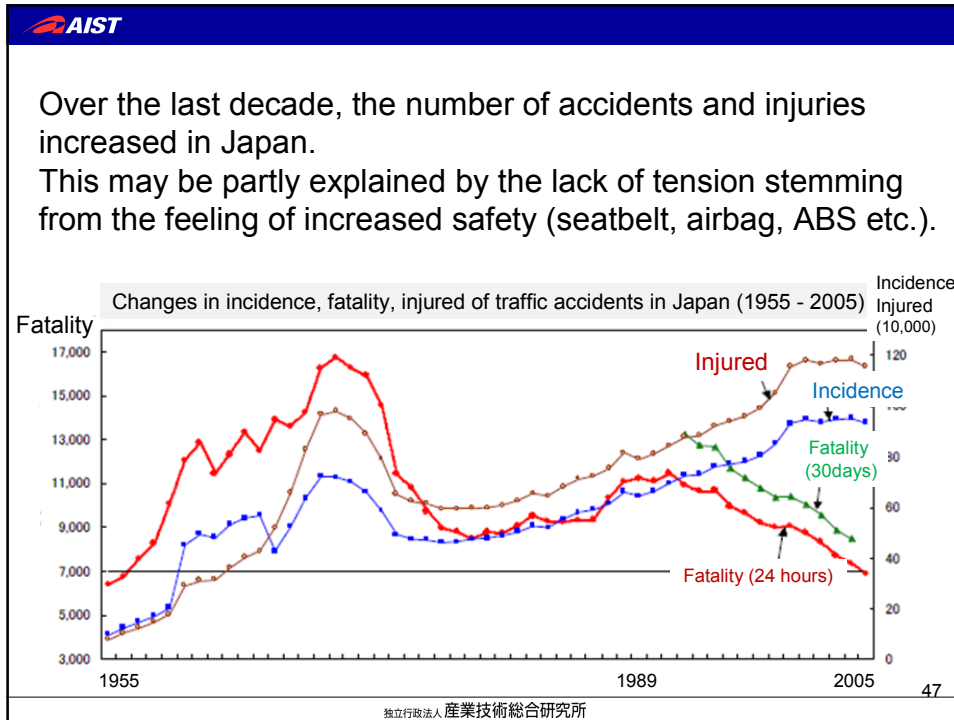


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    graph TD
      A[Introduction of compulsory seat belt wearing law] --> B[Drivers feel safer than before]
      B --> C[Lack of tension while driving]
      C --> D[Increase in risk to pedestrians and bicycles]
      B --> E[Decrease in mortality risk of drivers per accident]
      C --> F[Increase in the number of accidents and injuries]
      E --> G[+]
      F --> G
      G --> H[Although the number of fatalities per accident decreases, the total number of fatalities of drivers remain unchanged.]
      D --> I[The number of total death may not decrease and even increase?]
  
```

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Risk Homeostasis

- “An individual has an inbuilt target level of acceptable risk which does not change”
- Because of this psychological trait, people tend to behave in a manner to negate the effects of safety and health improving measures.
- In order to reduce risk, it is more important to make lower the target level than introducing safety measures.

There are many examples of risk homeostasis (= risk compensation).

- low-salt or low-calorie foods/drinks
- fuel-efficient car / hybrid car
- recyclable bottles

Target Risk 2
A new psychology of safety and health
What works? What doesn't? And why...
Gerald J.S. Wilde

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Should we prohibit DDT's use?

DDT is one of the persistent organic pollutants (POPs), which has the following properties; 1) persistence in the environment, 2) long-range transport, 3) bioaccumulation in human and animal tissue, 4) toxicity on human health and the environment.

Stockholm Convention (an international legally binding agreement on POPs) went into effect in May 2004.

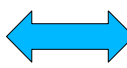



- Elimination of intentionally produced POPs (Article 3)
aldrin, chlordane, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, PCBs, and toxaphene
- Restrictions on intentionally produced POPs (Article 4)
DDT(dichloro-diphenyl-trichloro-ethane)
- Release reduction/elimination (Article 5)
dioxins and furans, and hexachlorobenzene and PCBs as byproducts

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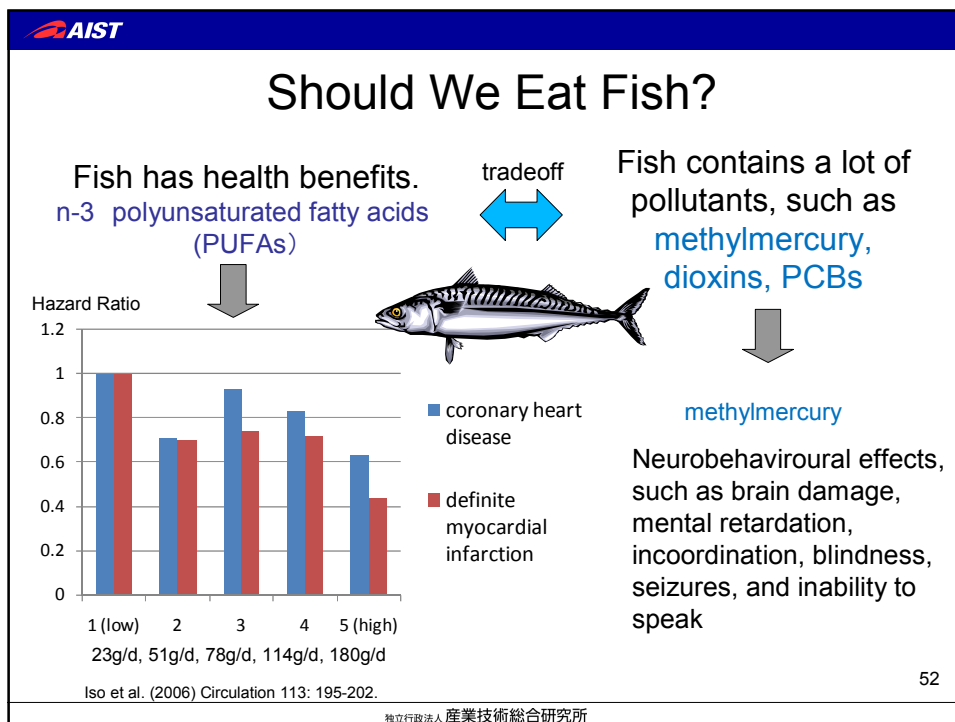
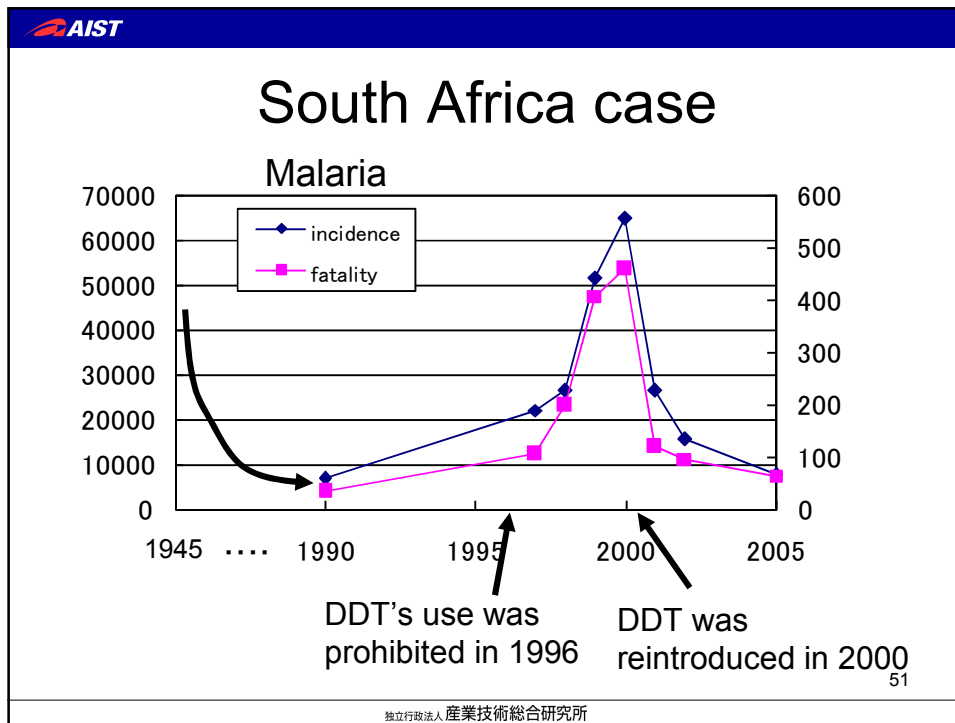
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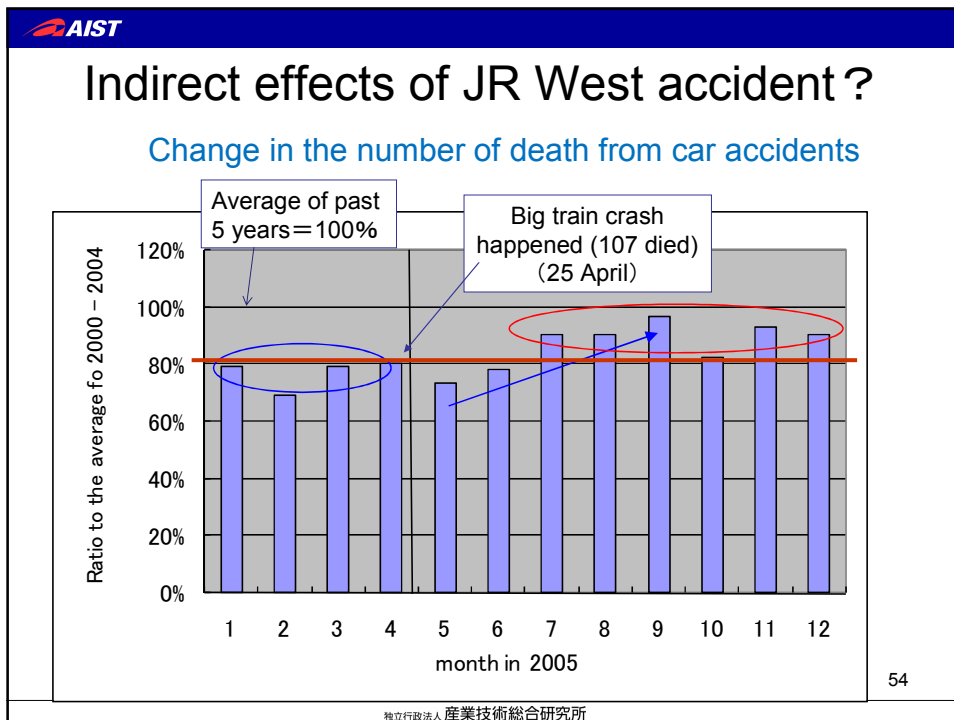
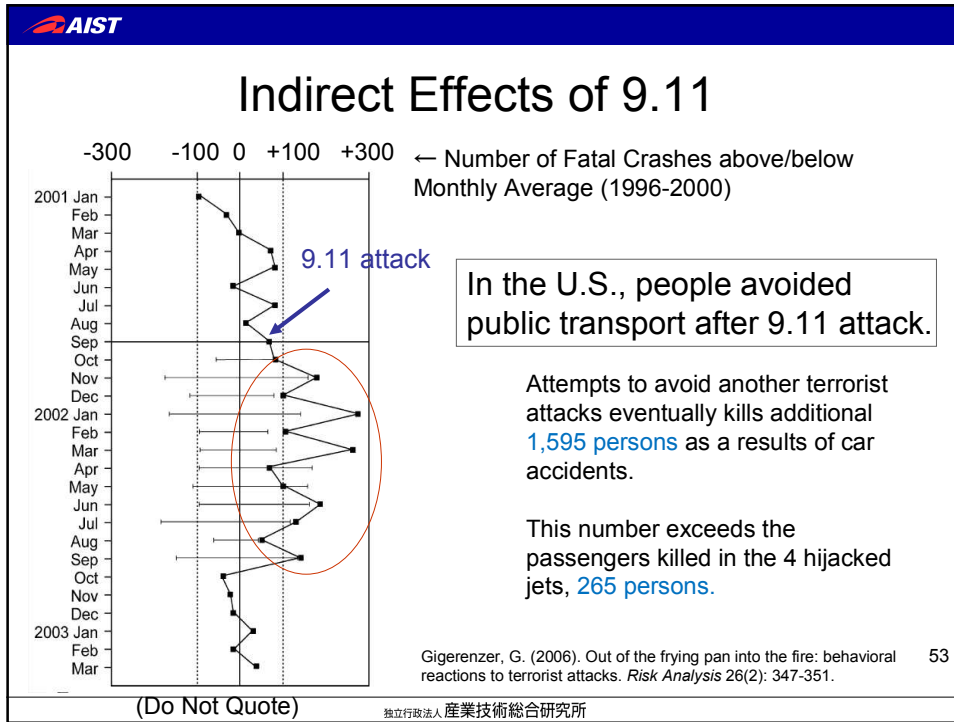
Risk and Benefit of DDT

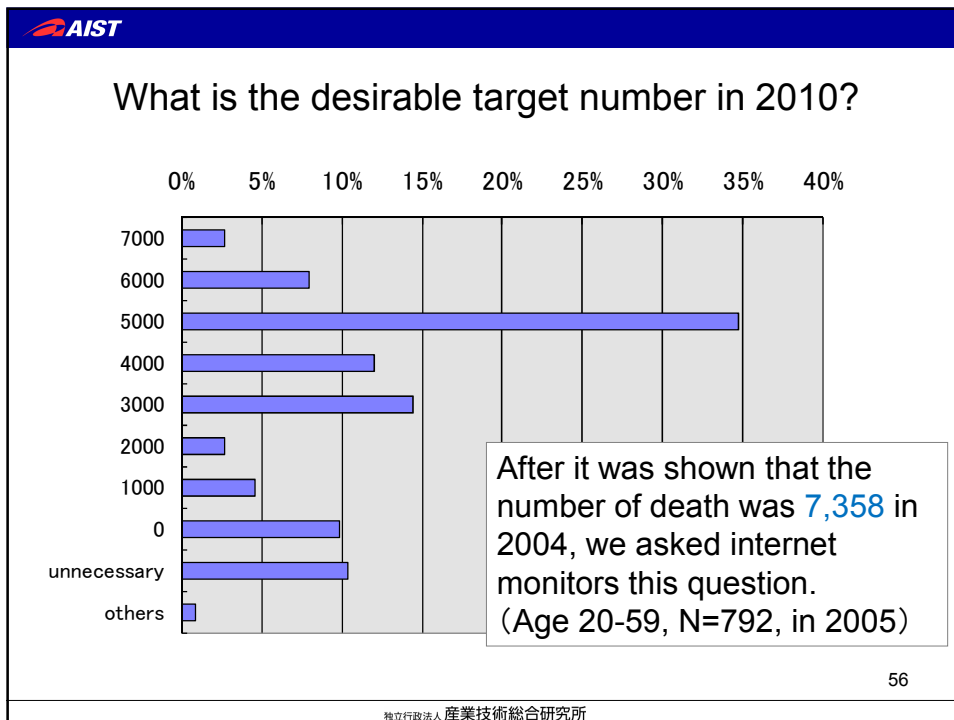
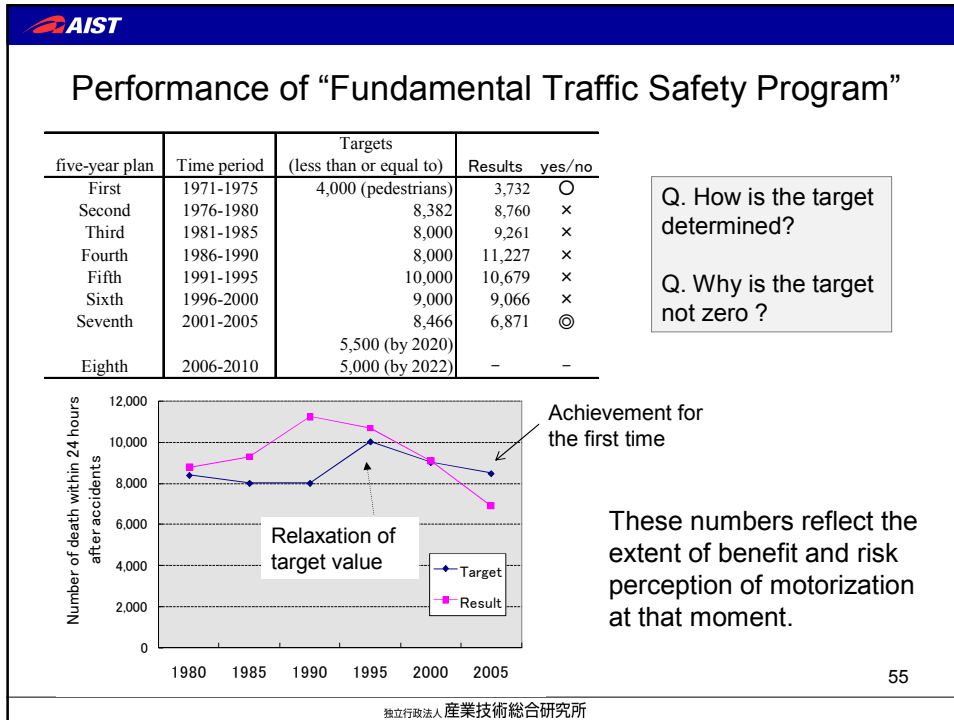
Use		Ban
Reduction of human health risk (Prevention of malaria infection)		Reduction of ecological risk (global level pollution)
		

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Railway safety or Road safety?

Vast amount of investment in railway safety

↓

Increase in train fares

↓

Some people change means of transportation from train to car

↓

Since the rate of accident and mortality of cars is much higher per travel distance, total mortality risk increases as a result of railway safety investment.

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Causes of cancer: a review of the evidence

Causes of cancer in the United States:

- Ionizing/ultraviolet radiation
- Prescription drugs/medicine procedures
- Salt/other food additives/contaminants
- Tobacco
- Adult diet / obesity
- Sedentary lifestyle
- Occupational factors
- Family history of cancer
- Viruses/other biologic agents
- Perinatal factors/growth
- Reproductive factors
- Alcohol
- Socioeconomic status
- Environmental pollution*

“Environmental pollution” contributes only 2%. Does the environmental policy have little power to reduce cancer death? However, “only 2%” means about 6,000 people since the annual number of cancer death amounts to about 300,000 in Japan.

Citation from “Harvard Report on Cancer Prevention” 1996 58

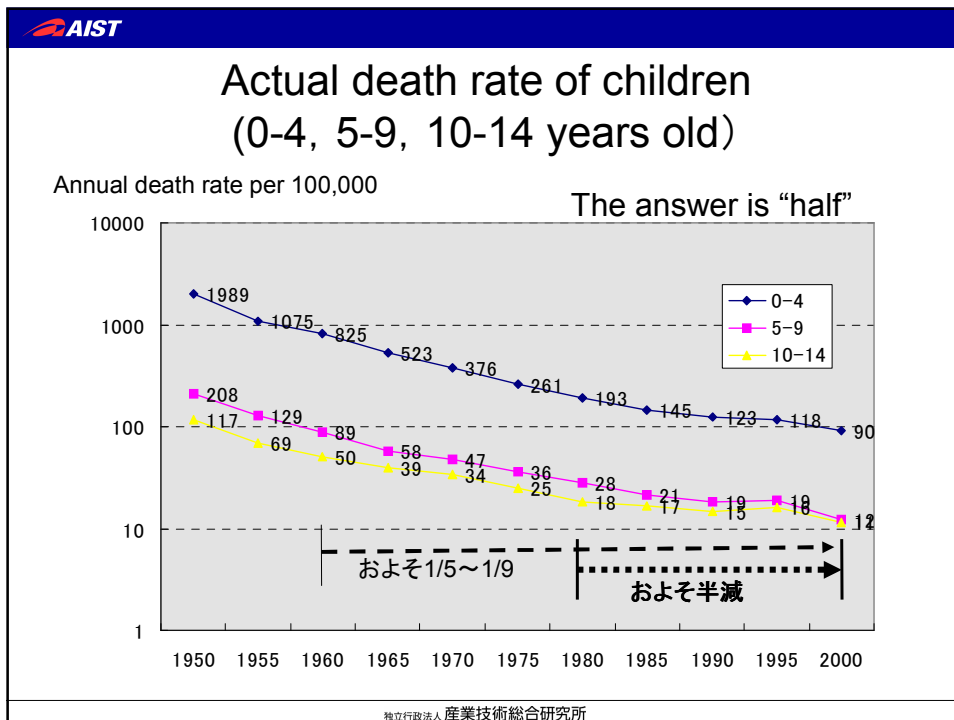
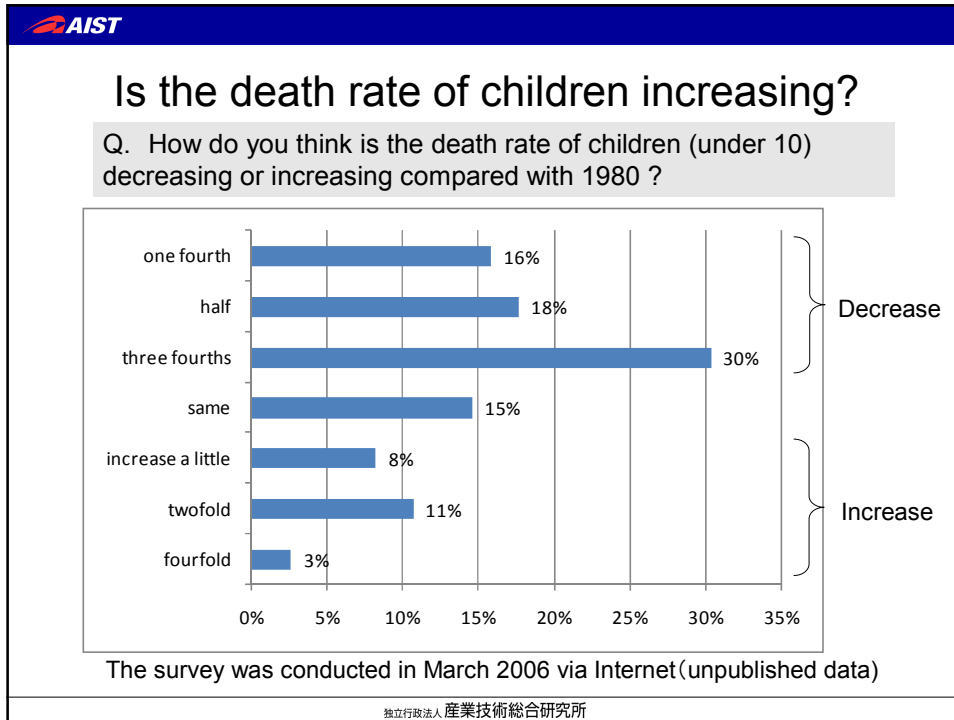
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Principles of Risk Management in “multiple risk world”

- When one risk is reduced, another risk may increase. →we should see the forest for the trees.
- People may behave in a manner to weaken the effects of safety measures. →We must plan these measures strategically.
- It costs to achieve safety and health. →We must be aware that since our budgets are limited, cost-effectiveness should be considered.
- It is not clear to what extent we should reduce risk. →Industry and government has a responsibility to explain the reasons of decision-making.

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Risk Perception



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Bias in risk perception – heuristics

- Representative heuristics
- Availability heuristics
 - ← Mass media, everyday experiences
- Anchoring and adjustment heuristics

In mass media coverage, news value increases as the phenomenon becomes rare. On the other hand, viewers tend to consider the increase in coverage as the increase in incidence.

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Ordering of perceived risk

	LOWV	College students	Active club members	Experts
Nuclear power	1	1	8	20
Motor vehicles	2	5	3	1
Handguns	3	2	1	4
Smoking	4	3	4	2
Motorcycles	5	6	2	6
Alcoholic beverages	6	7	5	3
General (private) aviation	7	15	11	12
Police work	8	8	7	17
Pesticides	9	4	15	8
Surgery	10	11	9	5
Fire fighting	11	10	6	18
Large construction	12	14	13	13
Hunting	13	18	10	23
Spray cans	14	13	23	26
Mountain climbing	15	22	12	29
Bicycles	16	24	14	15
Commercial aviation	17	16	18	16
Electric power	18	19	19	9
Swimming	19	30	17	10
Contraceptives	20	9	22	11
Skiing	21	25	16	30
X-rays	22	17	24	7
High-school and college football	23	26	21	27
Railroads	24	23	20	19
Food preservatives	25	12	28	14
Food coloring	26	20	30	21
Power mowers	27	28	25	28
Prescription antibiotics	28	21	26	24
Home appliances	29	27	27	22
Vaccinations	30	29	29	25

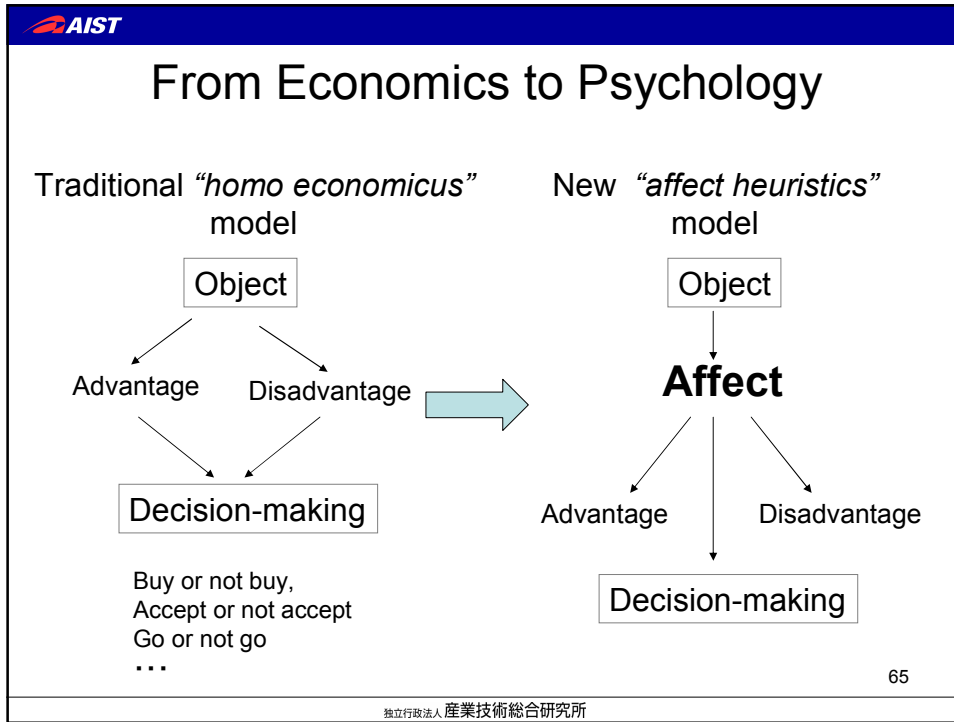
Two psychological factors explain their perceptions.

Factor 1: Dread Risk

Factor 2: Unknown Risk

Paul Slovic (1987). Perception of risk. *Science* 236:280-285.

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Two Modes of Thinking

“Dance of affect and reason” (Slovic 2007)

System 1: Experimental System	System 2: Analytic System
Affective: pleasure-pain oriented	Logical: reason oriented (what is sensible)
Connections by association	Connections by logical assessment
Behavior mediated by feelings from past experiences	Behavior mediated by conscious appraisal of events
Encodes reality in concrete images, metaphors, and narratives	Encodes reality in abstract symbols, words, and numbers
More rapid processing: oriented toward immediate action	Slower processing: oriented toward delayed action
Self-evidently valid: “experiencing is believing”	Requires justification via logic and evidence
Cerebral limbic system	Cerebral neocortex (prefrontal cortex)

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From Psychology to Brain Science

Brain

Abstract thinking
Quantitative thinking
Large number
Planning for the future

prefrontal cortex

inside → cerebral limbic system (old brain)

Small group in the near term hunting and gathering

Occipital lobe, Parietal lobe, Temporal lobe, Cerebellum, Cerebral cortex

(new brain)

In order to achieve risk governance and sustainable development, we should make use of "prefrontal cortex".

<http://en.wikipedia.org/wiki/Brain>

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Toward good risk governance

- Government: policy making based on risk analysis
- Industry: implementation of voluntary risk assessment and management
- Researchers/ Scientists: Risk research and information dissemination about risk
- General public: understanding risk and participation in decision-making

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