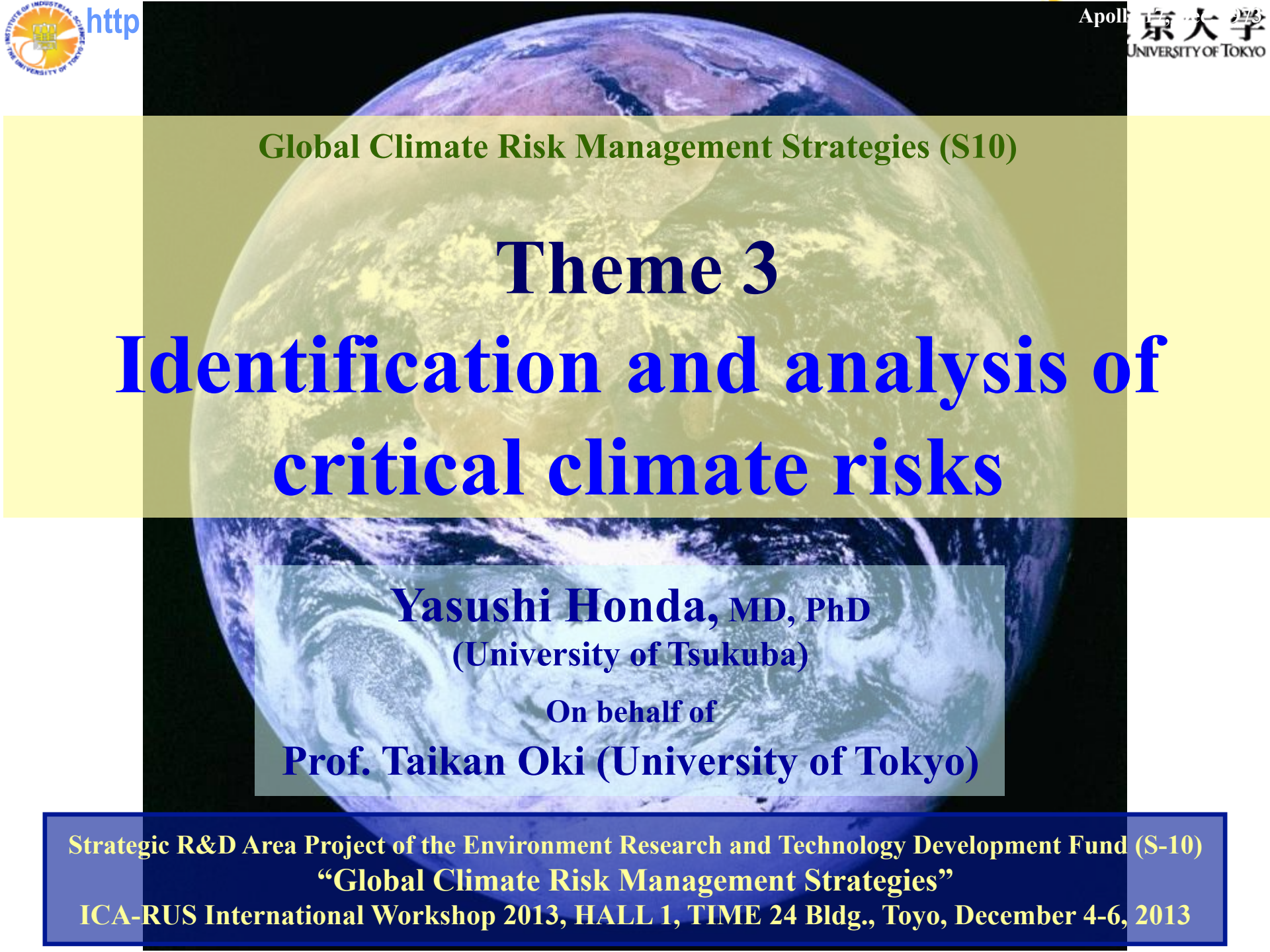

Global Climate Risk Management Strategies (S10)

Theme 3
Identification and analysis of critical climate risks

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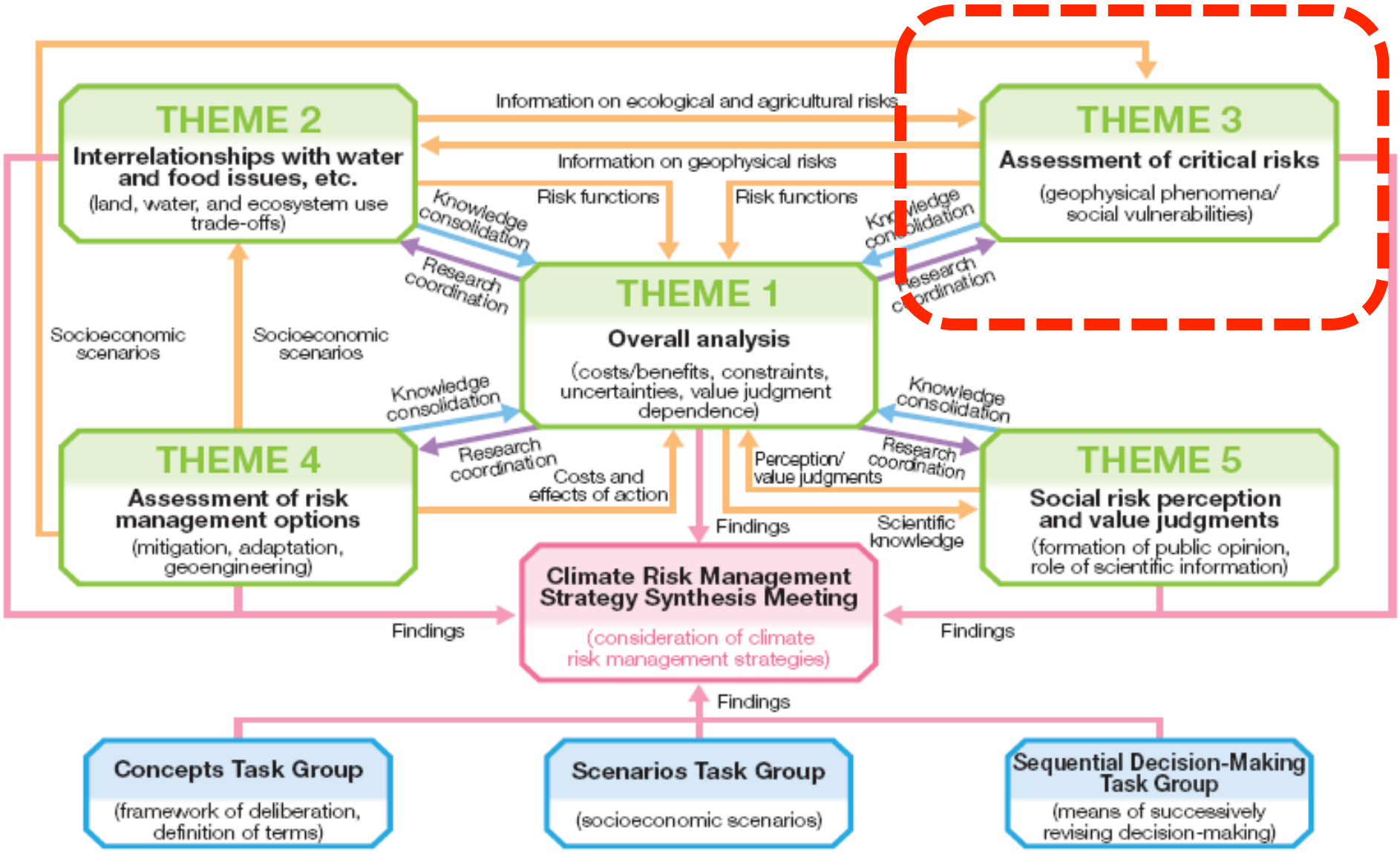
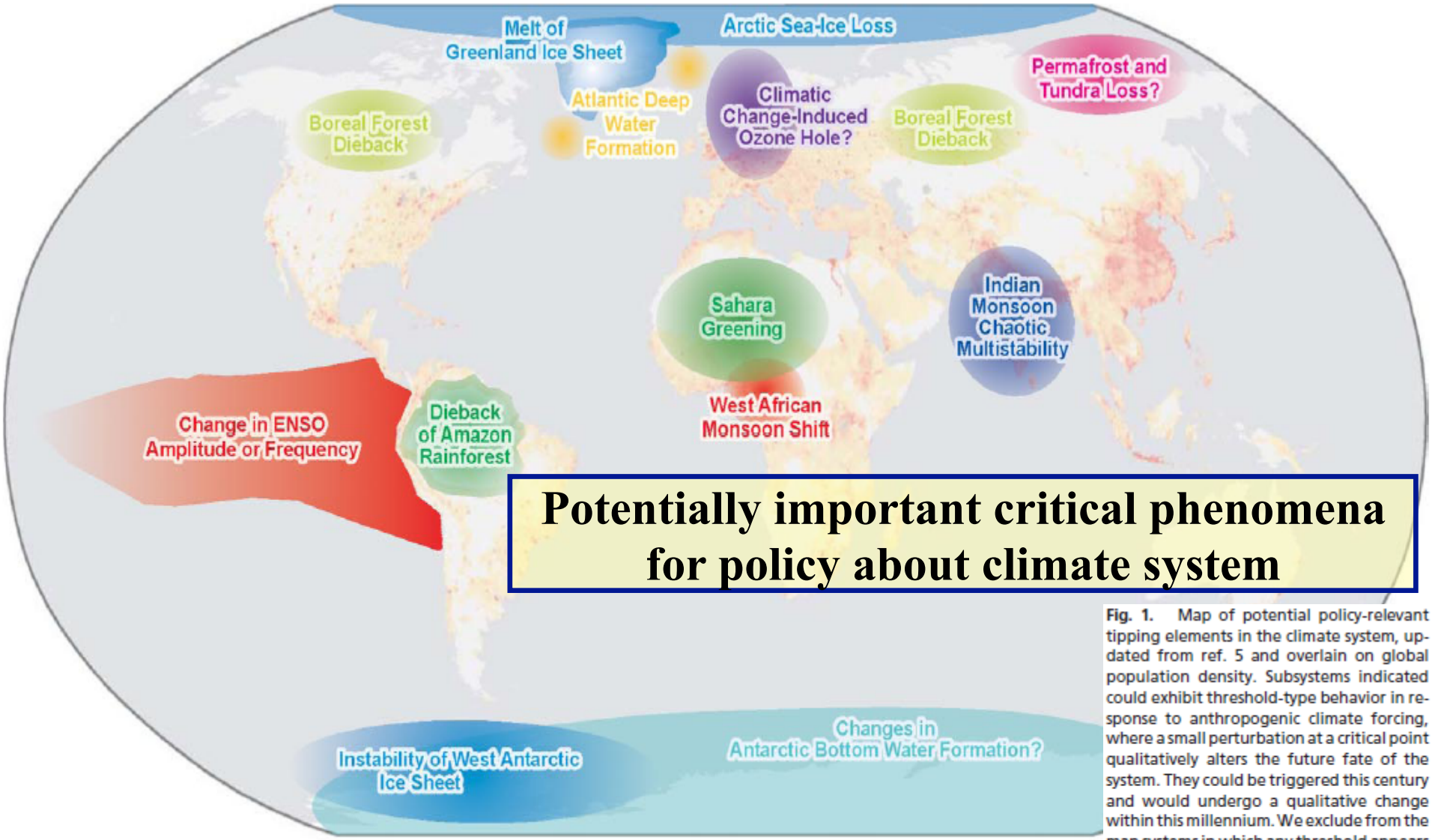
"Global Climate Risk Management Strategies"
ICA-RUS International Workshop 2013, HALL 1, TIME 24 Bldg., Toyo, December 4-6, 2013


THEME 2
Interrelationships with water and food issues, etc.
(land, water, and ecosystem use trade-offs)
THEME 3
Assessment of critical risks
(geophysical phenomena/ social vulnerabilities)
THEME 1
Overall analysis
(costs/benefits, constraints, uncertainties, value judgment dependence)
THEME 4
Assessment of risk management options
(mitigation, adaptation, geoengineering)
THEME 5
Social risk perception and value judgments
(formation of public opinion, role of scientific information)
Climate Risk Management Strategy Synthesis Meeting
(consideration of climate risk management strategies)
Concepts Task Group
(framework of deliberation, definition of terms)
Scenarios Task Group
(socioeconomic scenarios)
Sequential Decision-Making Task Group
(means of successively revising decision-making)
Information on ecological and agricultural risks
Information on geophysical risks
Risk functions
Risk functions
Knowledge consolidation
Research coordination
Socioeconomic scenarios
Socioeconomic scenarios
Costs and effects of action
Perception/ value judgments
Scientific knowledge
Findings
Findings
Findings
Findings

(Timothy M. Lenton, et al., PNAS, 2008)



Potentially important critical phenomena for policy about climate system

Fig. 1. Map of potential policy-relevant tipping elements in the climate system, updated from ref. 5 and overlain on global population density. Subsystems indicated could exhibit threshold-type behavior in response to anthropogenic climate forcing, where a small perturbation at a critical point qualitatively alters the future fate of the system. They could be triggered this century and would undergo a qualitative change within this millennium. We exclude from the map systems in which any threshold appears inaccessible this century (e.g., East Antarctic Ice Sheet) or the qualitative change would appear beyond this millennium (e.g., marine methane hydrates). Question marks indicate systems whose status as tipping elements is particularly uncertain.

Geophysical tipping elements
Risk Assessment

S10-1
Synthesis analysis

Risk
Identification
Is there any unanticipated risk?

Risk
Analysis
Occurrence probability?
Uncertainty?

Risk
Evaluation
Effect to society?

S10-3-(1)
Risk analysis

S10-3-(4), (5), & (6)
Evaluation of risk characteristic of geophysical critical phenomenon using climate model

S10-3-(2), (3), & (5)
Influence function according to climate change/variability and social change

S10-2
Risks of ecosystem & agriculture

S10-4
Socio-economic scenario

Table 1. Policy-relevant potential future tipping elements in the climate system and (below the empty line) candidates that we considered but failed to make the short list*

Tipping element	Feature of system, F (direction of change)	Control parameter(s), ρ	Critical value(s),† ρ_{crit}	Global warming†‡	Transition timescale,† T	Key impacts
Arctic summer sea-ice	Areal extent (−)	Local ΔT_{air}, ocean heat transport	Unidentified§	+0.5–2°C	≈10 yr (rapid)	Amplified warming, ecosystem change
Greenland ice sheet (GIS)	Ice volume (−)	Local ΔT_{air}	+≈3°C	+1–2°C	>300 yr (slow)	Sea level +2–7 m
West Antarctic ice sheet (WAIS)	Ice volume (−)	Local ΔT_{air}, or less ΔT_{ocean}	+≈5–8°C	+3–5°C	>300 yr (slow)	Sea level +5 m
Atlantic thermohaline circulation (THC)	Overturning (−)	Freshwater input to N Atlantic	+0.1–0.5 Sv	+3–5°C	≈100 yr (gradual)	Regional cooling, sea level, ITCZ shift
El Niño–Southern Oscillation (ENSO)	Amplitude (+)	Thermocline depth, sharpness in EEP	Unidentified§	+3–6°C	≈100 yr (gradual)	Drought in SE Asia and elsewhere
Indian summer monsoon (ISM)	Rainfall (−)	Planetary albedo over India	0.5	N/A	≈1 yr (rapid)	Drought, decreased carrying capacity
Sahara/Sahel and West African monsoon (WAM)	Vegetation fraction (+)	Precipitation	100 mm/yr	+3–5°C	≈10 yr (rapid)	Increased carrying capacity
Amazon rainforest	Tree fraction (−)	Precipitation, dry season length	1,100 mm/yr	+3–4°C	≈50 yr (gradual)	Biodiversity loss, decreased rainfall
Boreal forest	Tree fraction (−)	Local ΔT_{air}	+≈7°C	+3–5°C	≈50 yr (gradual)	Biome switch
Antarctic Bottom Water (AABW)*	Formation (−)	Precipitation–Evaporation	+100 mm/yr	Unclear¶	≈100 yr (gradual)	Ocean circulation, carbon storage
Tundra*	Tree fraction (+)	Growing degree days above zero	Missing‖	—	≈100 yr (gradual)	Amplified warming, biome switch
Permafrost*	Volume (−)	$\Delta T_{permafrost}$	Missing‖	—	<100 yr (gradual)	CH_4 and CO_2 release
Marine methane hydrates*	Hydrate volume (−)	$\Delta T_{sediment}$	Unidentified§	Unclear¶	10^3 to 10^5 yr ($>T_E$)	Amplified global warming
Ocean anoxia*	Ocean anoxia (+)	Phosphorus input to ocean	+≈20%	Unclear¶	≈10^4 yr ($>T_E$)	Marine mass extinction
Arctic ozone*	Column depth (−)	Polar stratospheric cloud formation	195 K	Unclear¶	<1 yr (rapid)	Increased UV at surface

Global Climate Risk Management Strategies

Theme 3; Identification and analysis of critical climate risks

◎ ①Risk analysis of a geophysical critical phenomenon and generalization of the whole of theme 3

- Consequences of geophysical critical phenomena are estimated based on record of the past historical climate change and the numeric simulation.

②Estimation of climate risk: water, health, energy, and food

- The risk of sectors caused by a climate change, such as water, health, energy, food, etc., is analyzed by combining a numeric simulation and the past disaster statistics, and is shown for every climate change level.

③Climate change risk identification around the Cryosphere and generalization of a geophysical risk identification

- About geophysical critical phenomena centering on the Cryosphere which may arise associate with a climate change, the generating mechanism, a threshold value, a scale, and uncertainty are grasped, and a geophysical risk is summarized.

④Climate change risk identification around the Oceanosphere

- About the geophysical critical phenomena in the Oceanosphere which may arise in associate with a climate change, the generating mechanism, a threshold value, a scale, and uncertainty are grasped.

⑤Evaluation of uncertainty and risks due to climate change

- About the geophysical critical phenomena which may arise in associate with a climate change, uncertainty, such as a threshold value of the generating and a scale, is statistically evaluated using a numeric simulation and paleoclimate data.

Expected outputs

- **Characterization of the geophysical critical but "should-be-avoided" phenomena accompanied by stopped thinking about the consequences**
  - **Global impact assessment including regional distribution**
  - **Achievement as research results from Japan**
  - **Probability analysis dependent on the climate change level**
  - **Contribution to rational goal setting of stabilization**
- **Contribution to the policy and science within 100 years and more**