RACC10 How to adapt to climate change(s),
Plenary Session 1 (Climate change -now and future -)
Kyoto International Conference Center, Room D
Kyoto, Japan, 6 October, 2017

Climate change adaptation for natural hazards and disasters

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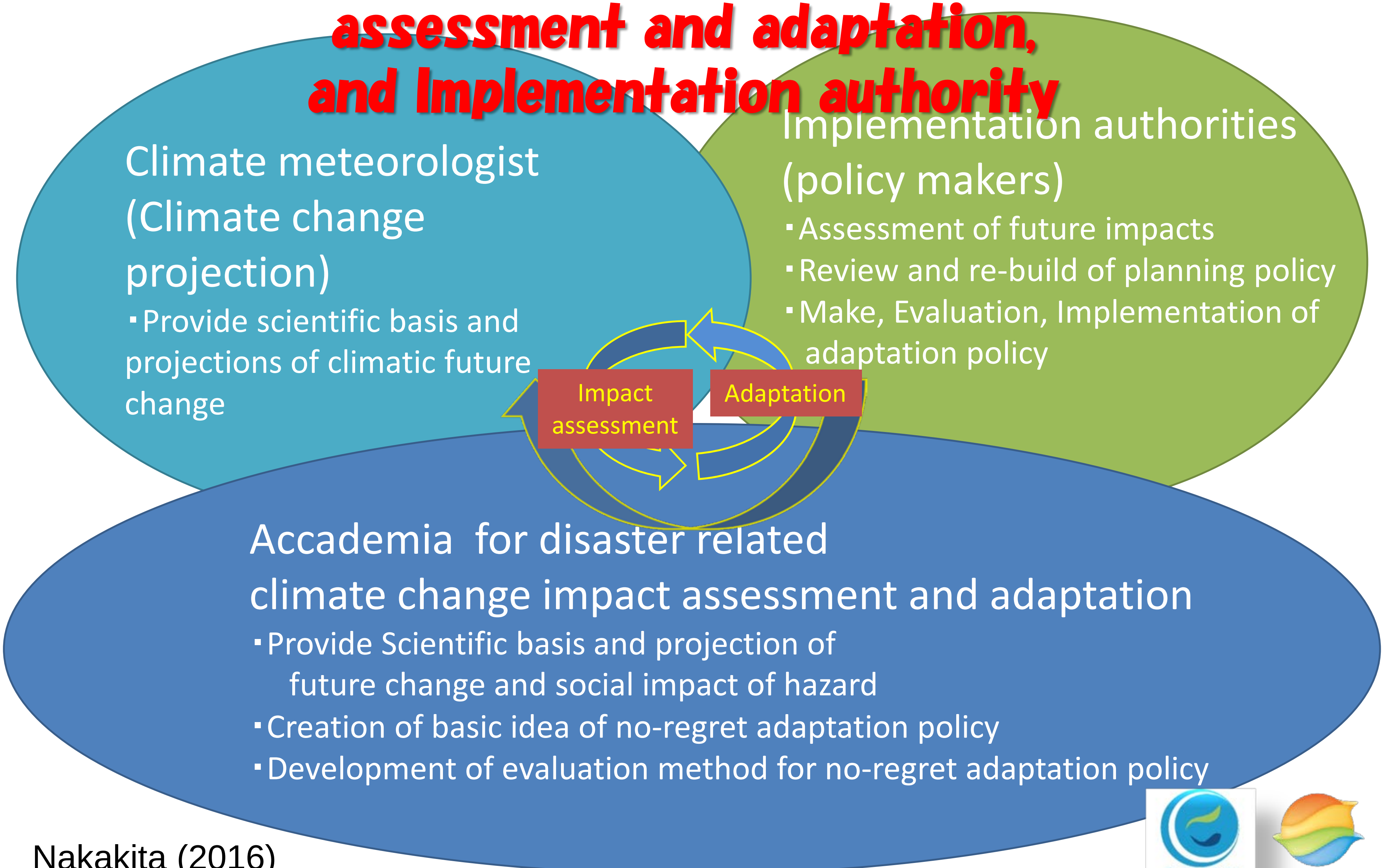
Importance of cooperation among Climatologist, Accademia for climate change assessment and adaptation, and Implementation authority



Nakakita (2016)

Disasters and Infrastructure Design

River discharge
Storm surge

Design value (Return period)

Range for disaster Mitigation

Range for disaster Prevention

Nakakita (2010,2011)

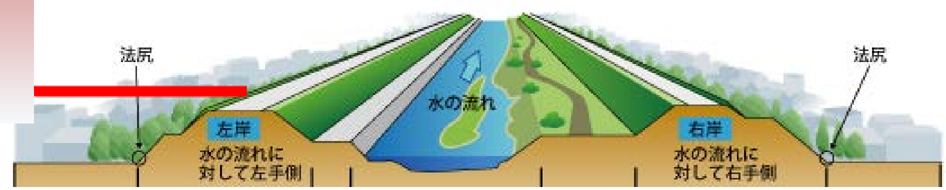
Disasters and Infrastructure Design

Survivability Critical, Edge of Survivability (The worst case)

Range for disaster <u>Mitigation</u>

Adaptation to new design value and the worst case

Uncertainty of projection (Probability)

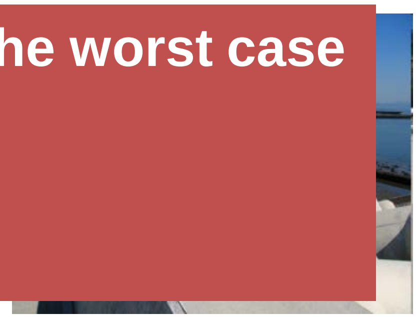


(Return period)

Range for disaster <u>Prevention</u>

Projection of design value and the worst case

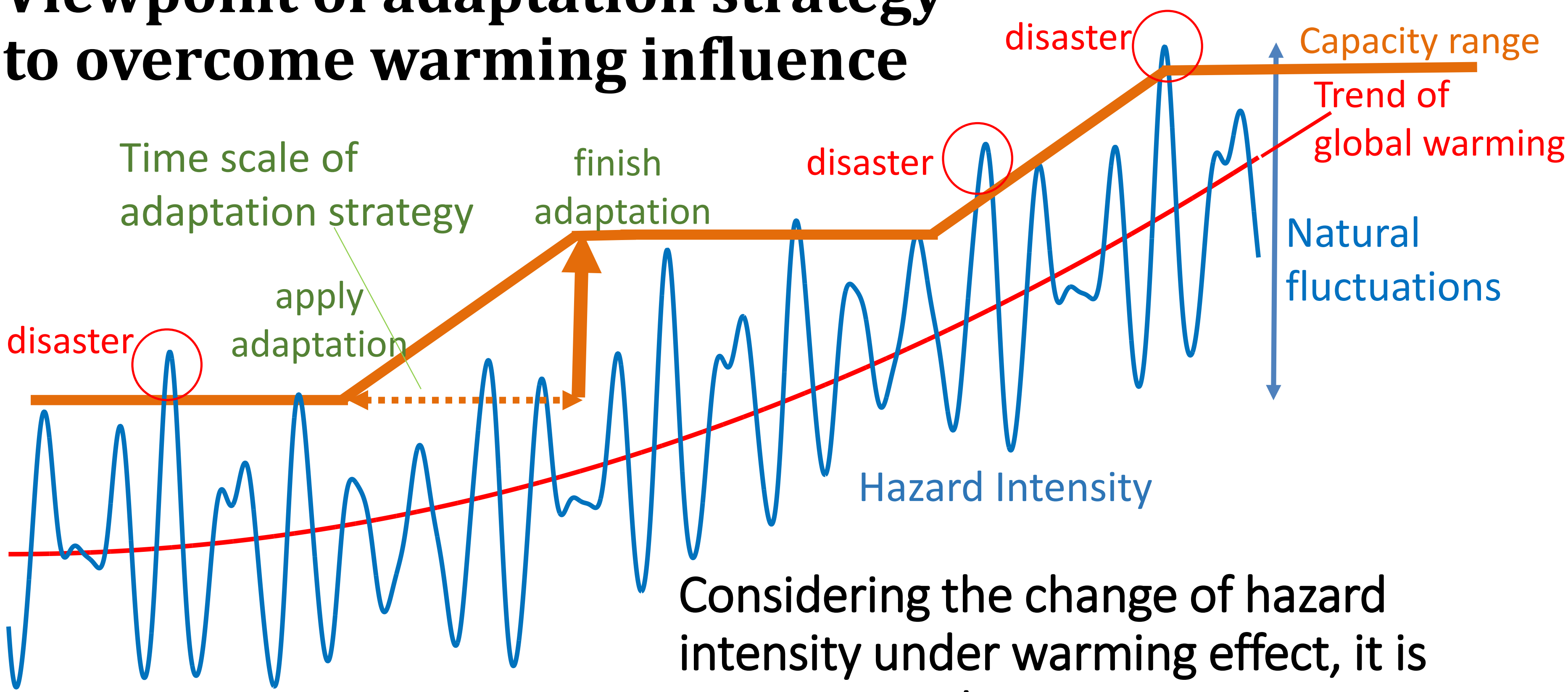
- How much change?
- Where is severe location?
- When does it become severe?



Nakakita (2010,2011)

Importance of Non-regret adaptation strategies with consideration for various changes

Viewpoint of adaptation strategy to overcome warming influence



Considering the change of hazard intensity under warming effect, it is Important to know:

- Time scale of global warming effect;
- Width of natural fluctuations;
- Time scale of adaptation strategy;
- Cost effectiveness.

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basic consideration

Sousei (創生) and Togo(統合) Program D supported by MEXT (2012-2022)

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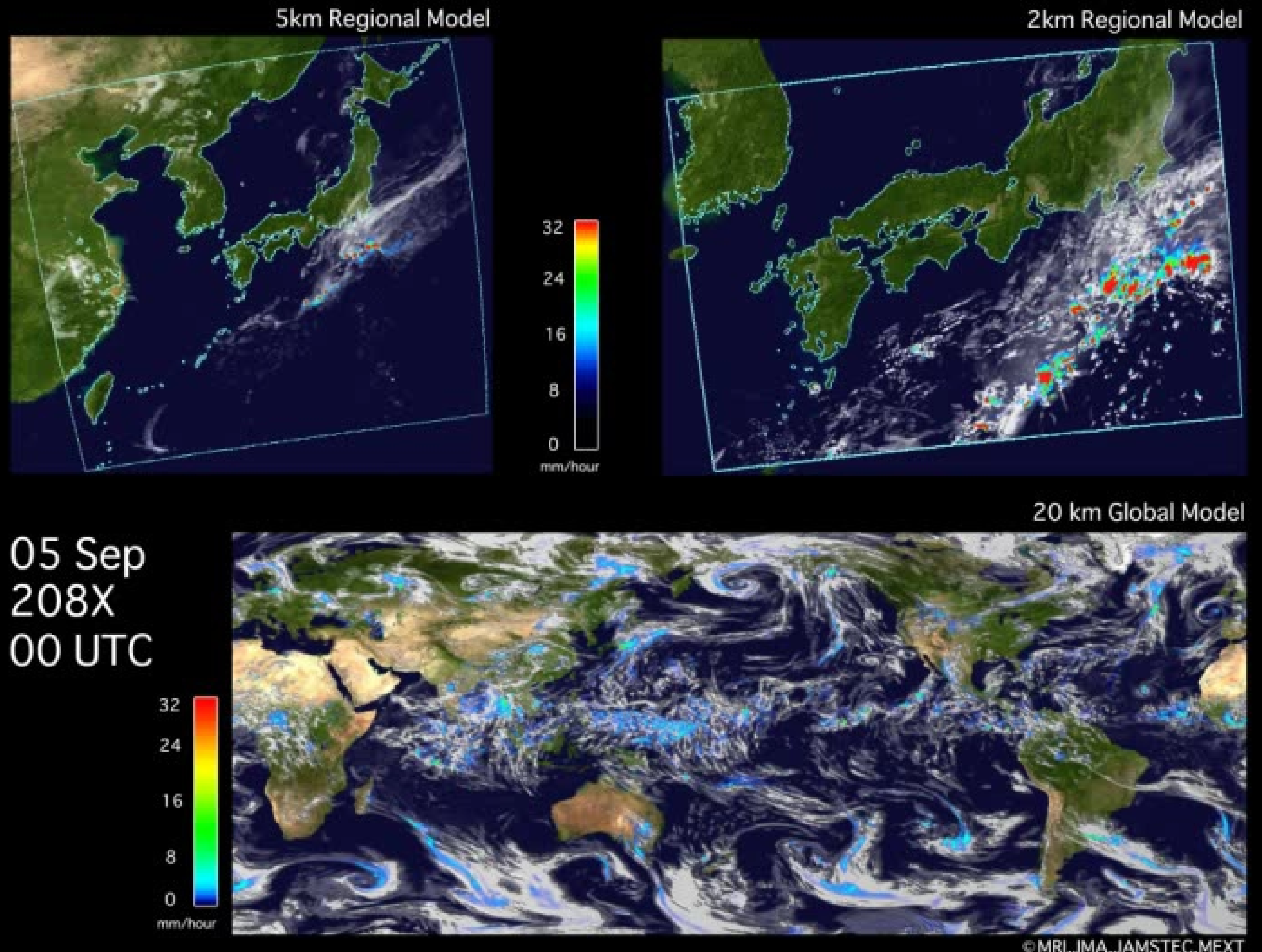
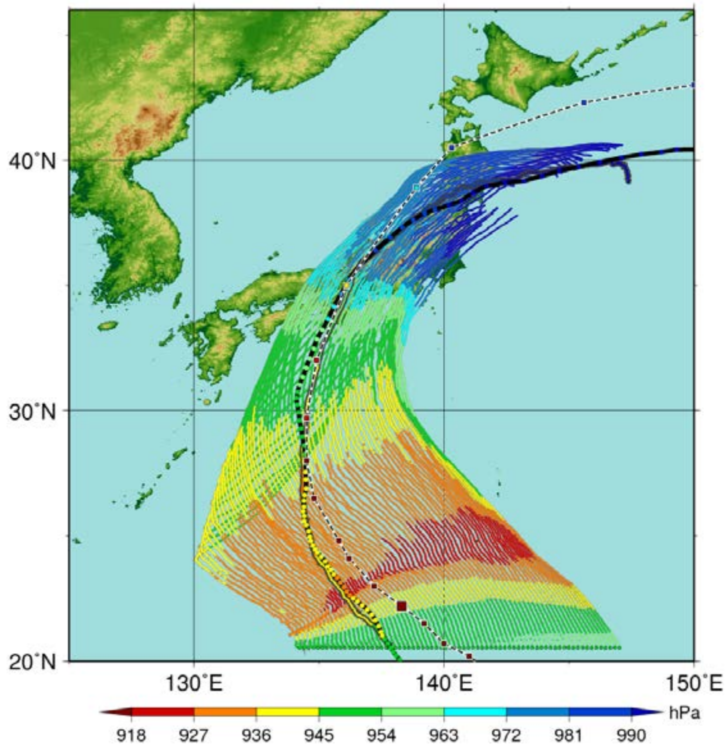
- Estimation of high accuracy probability (change of design value)
  - Estimation of Probabilistic density distribution using multiple predictions（ensemble simulations) of coarse-resolution models of（Theme C GCM60 (60km-Global climate model）and CMIP5)) ＝> d4PDF
  - Conversion of coarse spatial resolution data into regional scale one using high spatiotemporal resolution models of GCM20(20km-Global climate model) or RCM５，２(2km, 5km-Regional climate model)（provided by Theme C)
- Assumption of the greatest external forcing – Survival chance
  - Worst typhoons (Collaborated with Theme C for artificial global warming)
  - Compound disasters
  - Assumptions of social scenarios
- Development of the consideration and philosophy of making non-regret adaptation strategy
  - Development of decision-making approach under large uncertainty
  - Development of decision-making approach under the worst scenarios without any probabilistic information
  - Creation of new sense of values, e.g., economic index of ecosystem

Nakakita（2012, 2015)

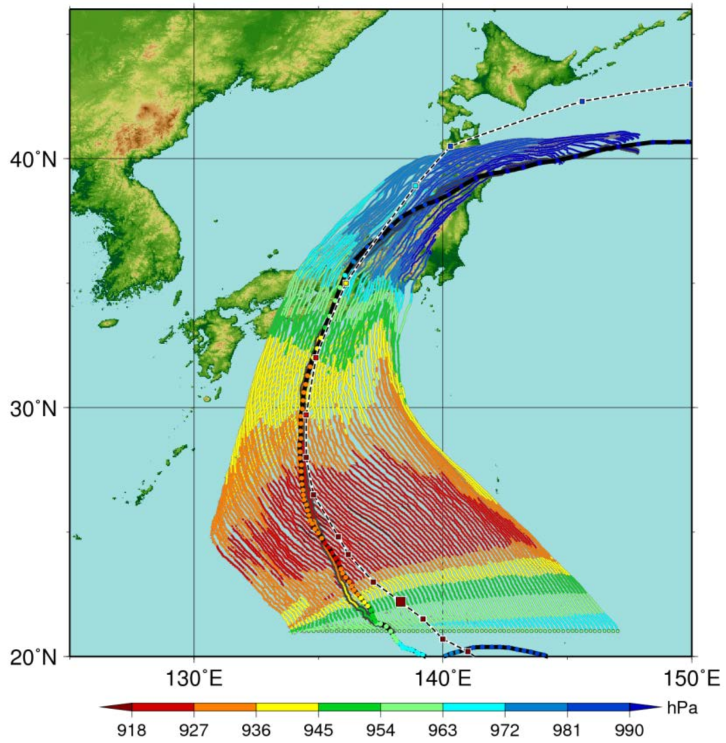

5km Regional Model
2km Regional Model
32
24
16
8
0
mm/hour
20 km Global Model
05 Sep
208X
00 UTC
32
24
16
8
0
mm/hour
©MRI,JMA,JAMSTEC,MEXT

Virtual Shifting of typhoon's initial position and PGW for typhoon vera at Ise-bay (a Worst CaseScenario)

Actual condition



PGW condition

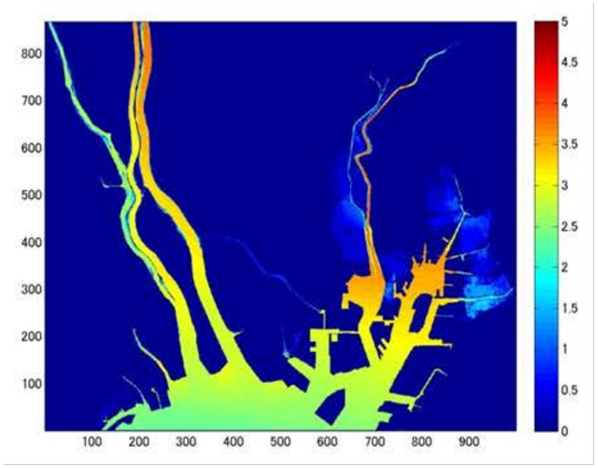


Max. wind	Reproduced	PGW	diffrence
Ise Bay	35.7(m/s)	41.1(m/s)	+5.4(m/s)
Osaka Bay	32.3	36.3	+4.0

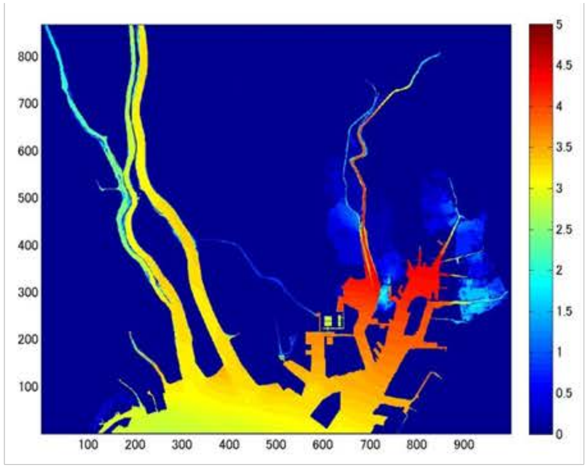
(DPRI：Oku, Takemi, Ishikawa)

Projected maximum storm surge height with inundation –typhoon Vera at Ise Bay-

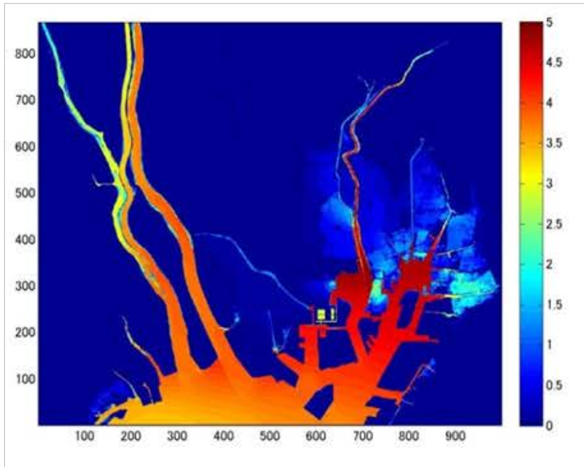
Typhoon Vera (historical run)



Extreme typhoon Vera (future climate)



Extreme and shifted typhoon Vera (future climate+ worst course)



Multiple flooding disaster (river and storm surge flooding)

- Worst scenario is different between storm surge and river flooding
- Storm surge
  - Key factors: central pressure and track of the typhoon, astronomical tide
- River flooding
  - Key factors: intensity and duration of precipitation

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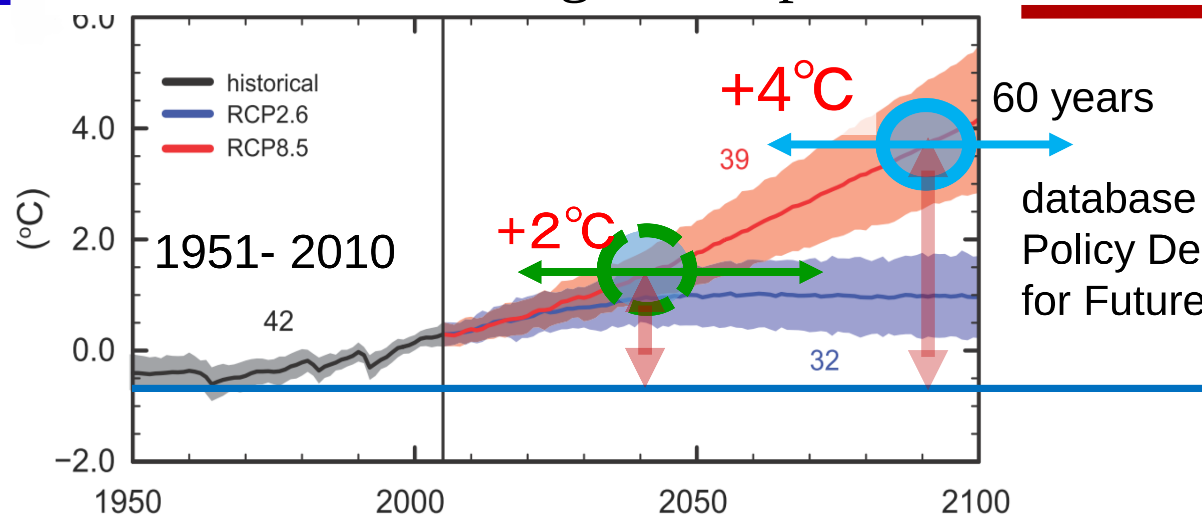
Shibutani et al, 2014

Experimental design of d4PDF

Global Averaged Temp.



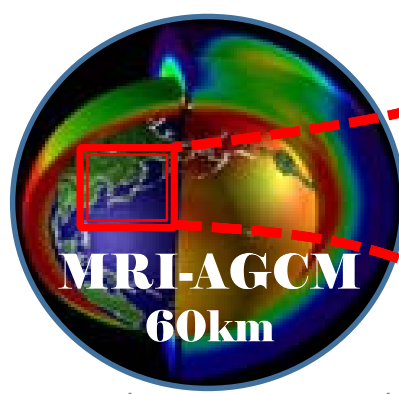
Global 60km AGCM — 100 member → 90 member

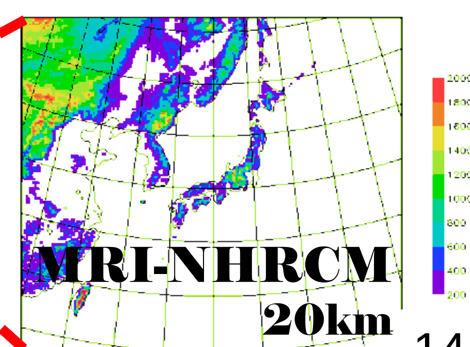
Japan 20km RCM — 50 member → 90member

Present — Future — (6ΔT × 15δT)

Detrend **60** yrs
Time series
×
6 AOGCM future SST
(CMIP5) (ΔT)
×
15 perturbation due to
observation (δT)

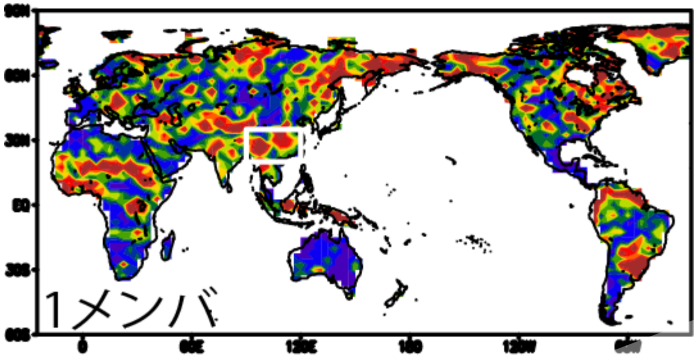
SST

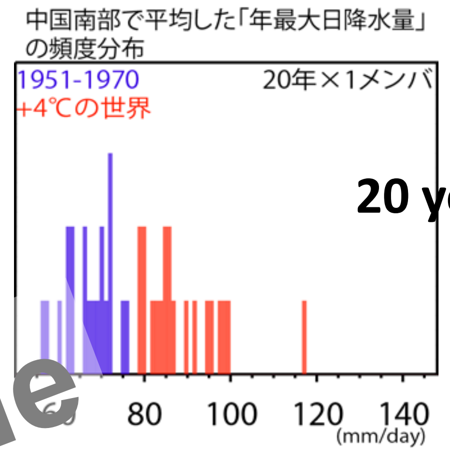




Frequency of annual maximum daily rainfall

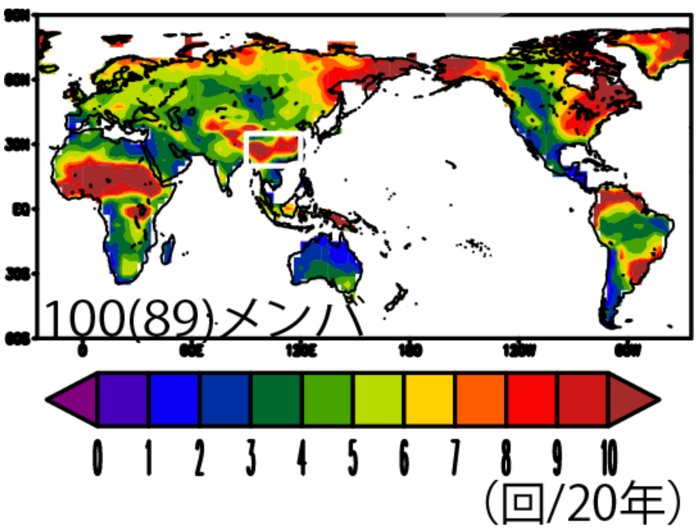
Analysis of ES 100x100 experimental analysis

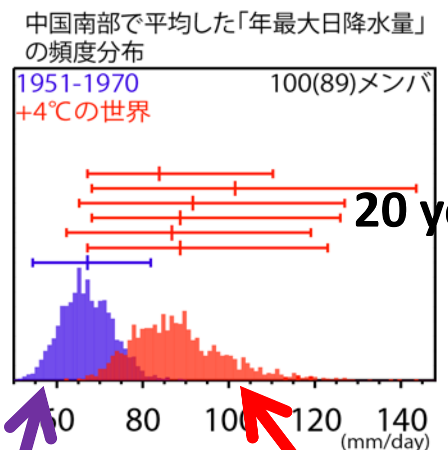




20 years ×1 members

Increase of ensemble manber





20 years×100 members

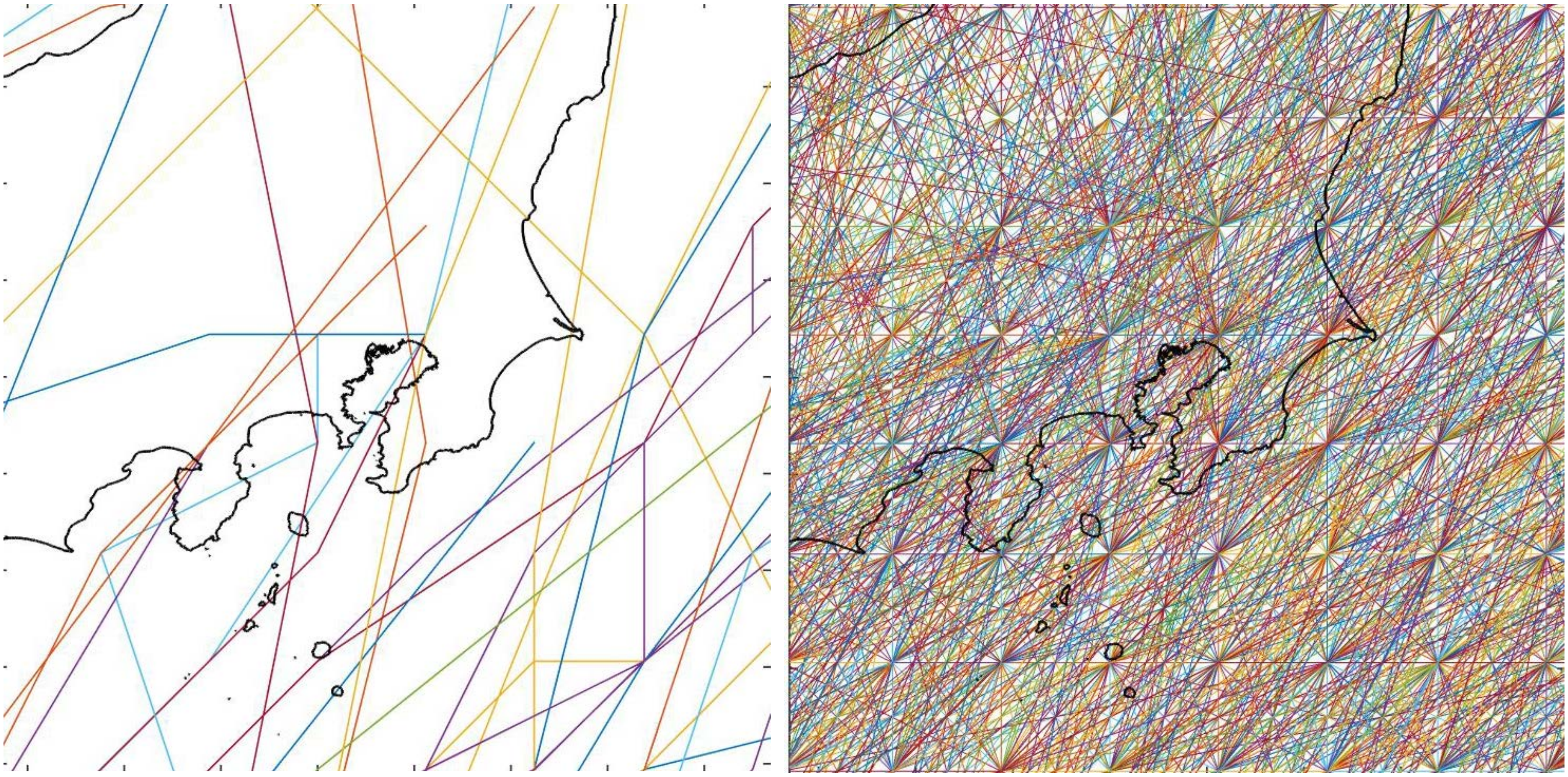
1951~1970

World of ＋4℃

Shiogama@NIES

Number of TC is insufficient

Mean landfall on Japan: 2.7/yr (MRI)

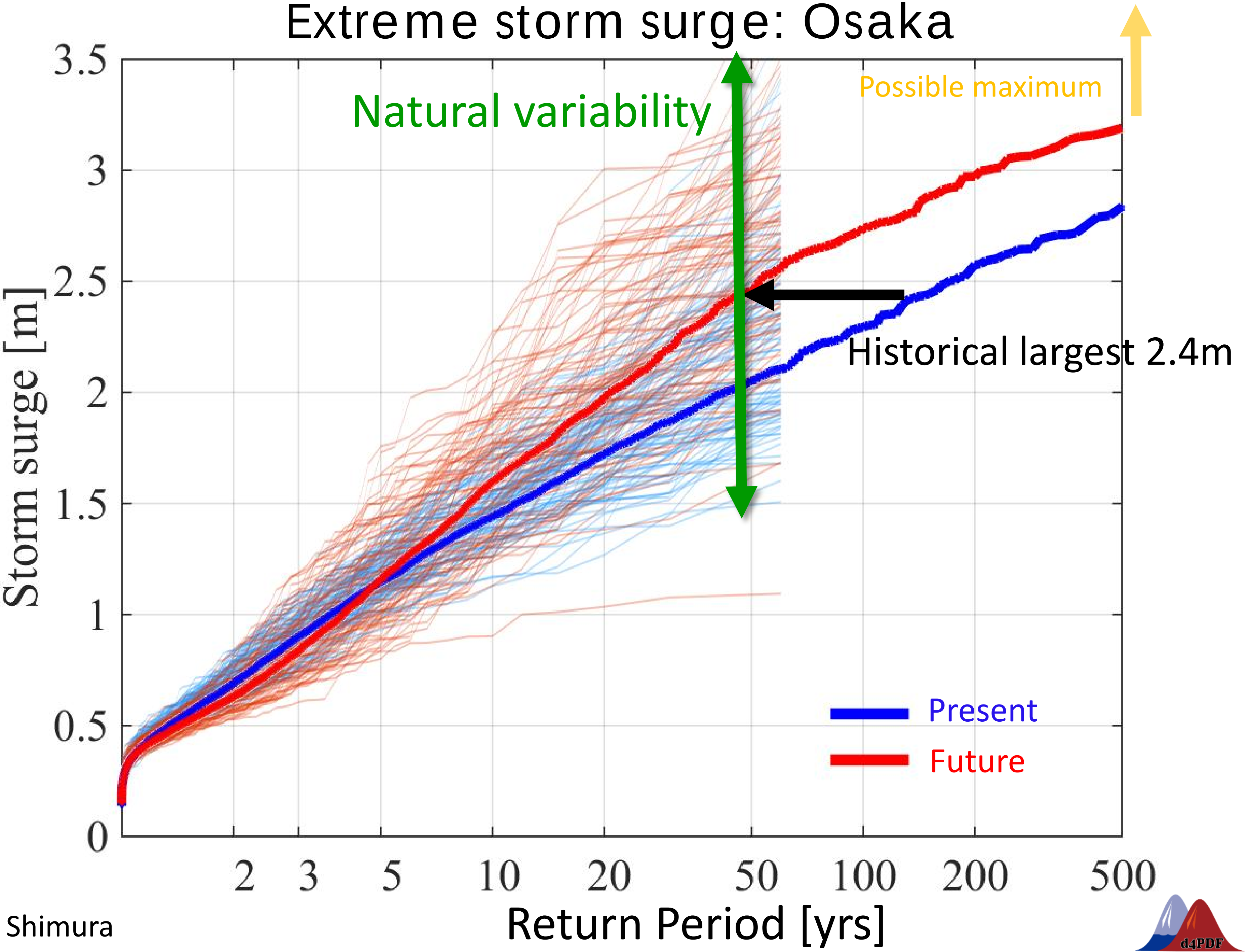


25 years climate run

d4PDF (5400 yrs)

By Shimura

Extreme storm surge: Osaka

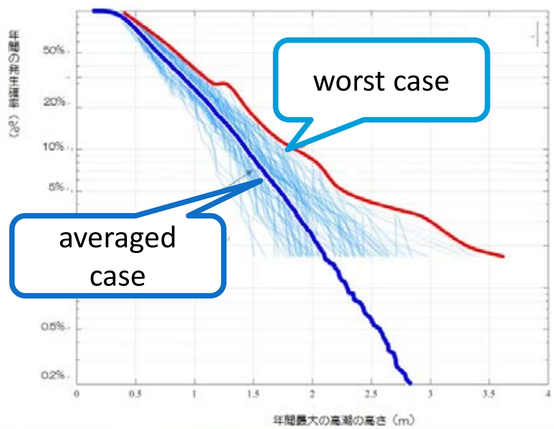


By Shimura

Development of variable strategies for no-regret adaptations

Tatano and Fujimi (2017)

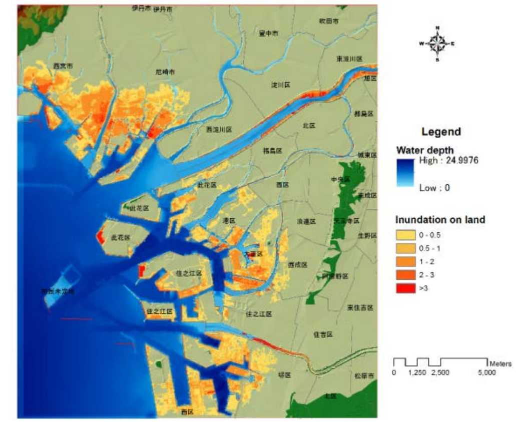
d4PDF/GCM-RCM



Inundation analysis

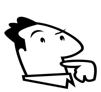
Assume multiple cases

…



Averaged risk scenario

頻度	年間確率			
10年に1回	10%			
20年に1回	5%			
50年に1回	2%			
100年に1回	1%			
200年に1回	0.5%			
		浸水の深さ		
		0.1m以上（床下浸水）	0.5m以上（床上浸水）	3.0m以上（家屋水没）



answerer

worst risk scenario

頻度	年間確率			
10年に1回	10%			
20年に1回	5%			
50年に1回	2%			
100年に1回	1%			
200年に1回	0.5%			
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Correct indication of similar risks as much as possible

Web questionnaire（CVM）

Estimation of the weight (α) of decision-making using averaged and worst risk scenarios

Averaged risk scenario

Worst risk scenario

$$V(f) = (1-\alpha)\int u(f(\omega))d\bar{p}(\omega) + \alpha \min_{p\in P}\int u(f(\omega))dp(\omega)$$

No-regret adaptation strategy

Decision-making model considering adaptation strategy（f）

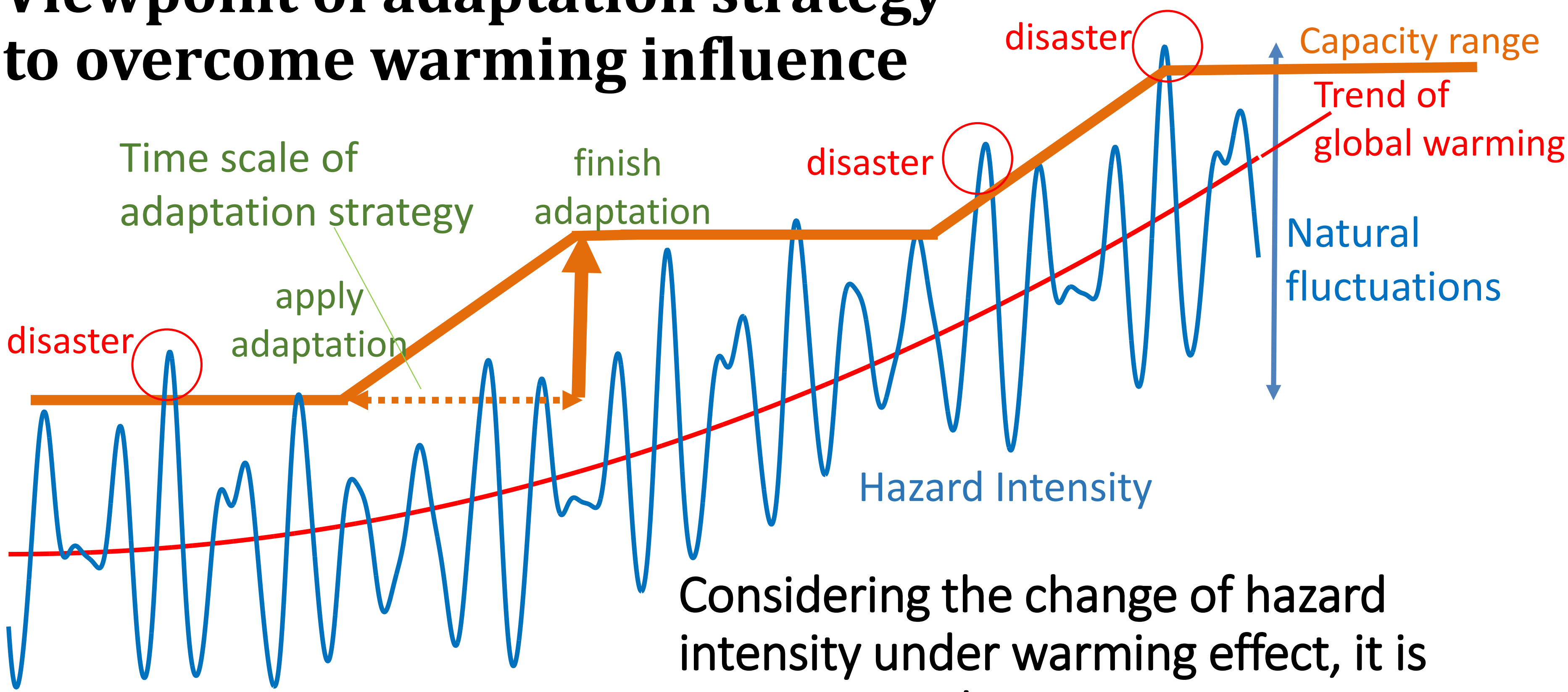
$$\underset{f\in\Omega}{Max}\int_0^T \{(1-\alpha)\int u_t(f_t(\omega_t))d\bar{p}_t(\omega_t) + \alpha\int u_t(f_t(\omega_t))dp_t(\omega_t)\}dt$$

reflection of socio-economic scenarios

reflection of 100-yrs seamless hazard prediction

Importance of Non-regret adaptation strategies with consideration for various changes

Viewpoint of adaptation strategy to overcome warming influence



Considering the change of hazard intensity under warming effect, it is Important to know:

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Summary (1)

1. Risk management deal with phenomena beyond design hazards. In this sense, it is very important to take into account the result from a worst class scenarios as one of the forcing hazard for disaster risk management under climate change.
2. Taking into consideration above items, I think, it is very important for climate change adaptation to discriminate more between planning with an uncertain design level and risk management with a worst case scenario.
3. Of cause, making the number of ensembles increase is essentially important. In this sense, d4PDF is very important and valuable data set.

Summary (2)

4. Ministry of Land, Infrastructure Transportation and Tourism (MLIT), in Japan have decided to introduce the concept of "the risk management with a worst case scenario" into "its official adaptation strategy" partly based on our activity under Kakushin and Sousei programs supported by the Minstry of Education, Culture, Sports, Science and Technology. The MLIT is waiting for an establishment of methodology of estimating the worst case class scenario, which could be uniformly applied nationwide.
5. The MLIT also started discussion on updating the master plan of flood protection taking adaptation methodologies into account based on projected design value and the worst case value.

Collaborative symposium and research meetings with implementation Ministry

National Olympic Memorial Youth Center, May 29, 2015
Organizer SOUSEI Program, MEXT / Water and Disaster Management Bureau, MLIT
Co-organizer Committee on Hydroscience and Hydraulic Engineering, JSCE
Committee on Earth Environment, JSCE

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Thank you for your kind attention

Joint Symposium for climate change projection and adaptation

Photo: Uji, Kyoto