On "Program for Risk Information on Climate Change" - post KAKUSHIN program named "SOUSEI" –

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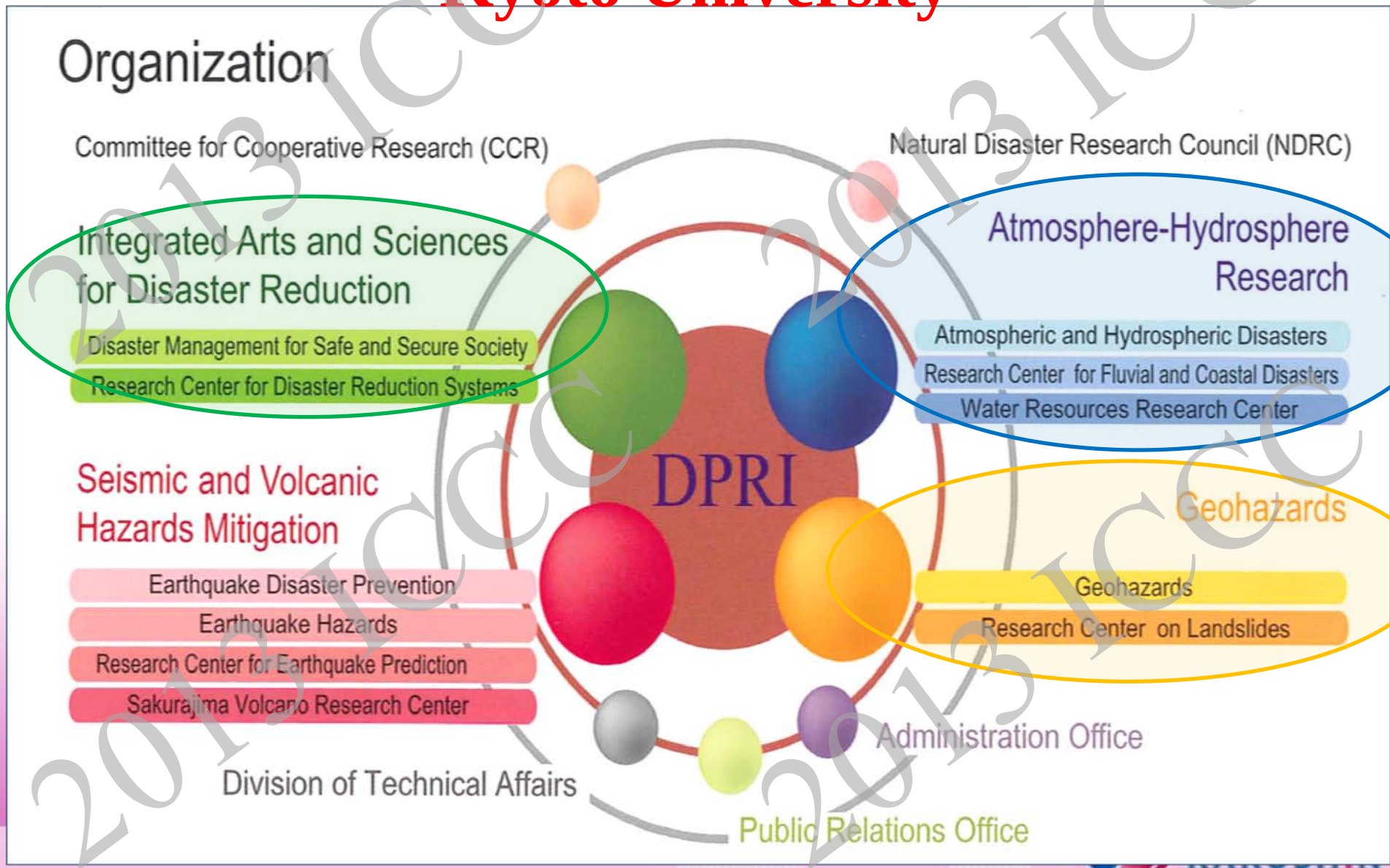
Launching of Sousei Program

- Kyousei(共生)Program:2002-2006
  - 20kmRCM (daily rainfall)
- Kakushin(革新)Program:2007-2011
  - 20kmGCM, 5,2,1kmRCM (hourly rainfall)
  - Natural Disaster (Inc. water resources)
- Sousei(創生)Program:2012-2016
  - Impact assessment and producing adaptation methodologies (First priority)
  - for Natural Disaster, Water resources, Ecosystem and Eco service (Kyoto University will lead the nation wide assessment team)

KAKUSHIN

Disaster Prevention Research Institute
Kyoto University



Outline

- **Climate change impact assessment under KakushinProgram (2007-2011)**
  - Impact of AGCM20 on extreme events climate impact assessment in Japan
  - Typical climate change assessment on disaster environment in Japan – projection of change in design value
  - Heading to adaptation :importance of taking a worst case scenario into consideration
- **Outline of the Sousei Program (2012-2016)**

Innovative Program of Climate Change Projection for the 21st Century

(KAKUSHIN Program)

by

Ministry of Education, Culture, Sports, Science and Technology (MEXT)

Secretariat of the Outreach Committee of the Program
Frontier Research Center for Global Change
Japan Agency for Marine-Earth Science and Technology

Participating groups and their studies

- ***Long-term global environmental projection***
  with an earth system model
  Kakushin Team 1
  - Frontier Research Center for Global Change (**FRCGC**) et al.

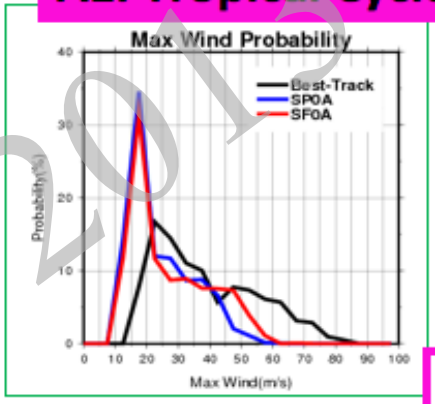
- ***Near-term climate prediction***
  Kakushin Team 2
  with a high-resolution coupled ocean-atmosphere GCM
  - Center for Climate System Research (**CCSR**) of the University of Tokyo et al.

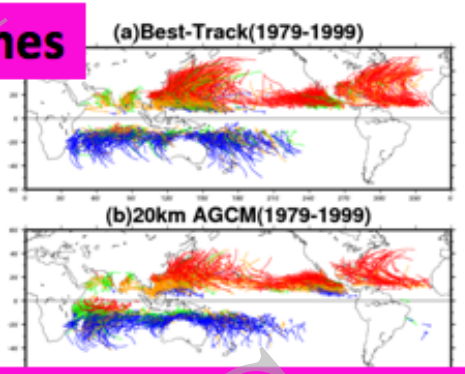
- ***Projection of changes in extremes in the future***
  with super-high resolution atmospheric models
  Kakushin Team 3
  - Meteorological Research Institute (**MRI**) et al.
  - **Disaster Prevention Research Institute (DPRI), Kyoto University**
  - **International Centre for Water Hazard and Risk Management (ICHARM), Public Work Research Institute (PWRI)**

Projection of the Change in Weather Extremes Using Super-High-Resolution Atmospheric Models in the KAKUSHIN Program

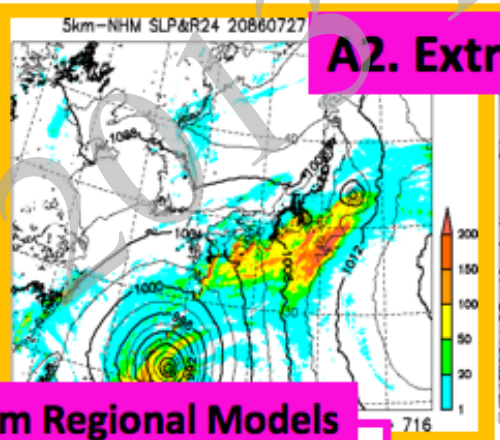
Akio Kitoh (MRI/JMA), Shoji Kusunoki (MRI/JMA), Eiichi Nakakita (DPRI/Kyoto-Univ.), Kuniyoshi Takeuchi (ICHARM/PWRI)

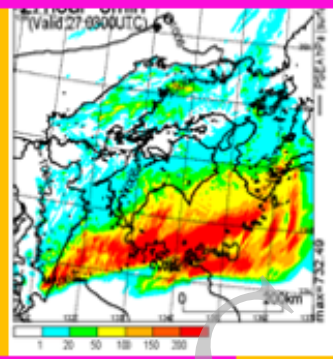
A1. Tropical Cyclones



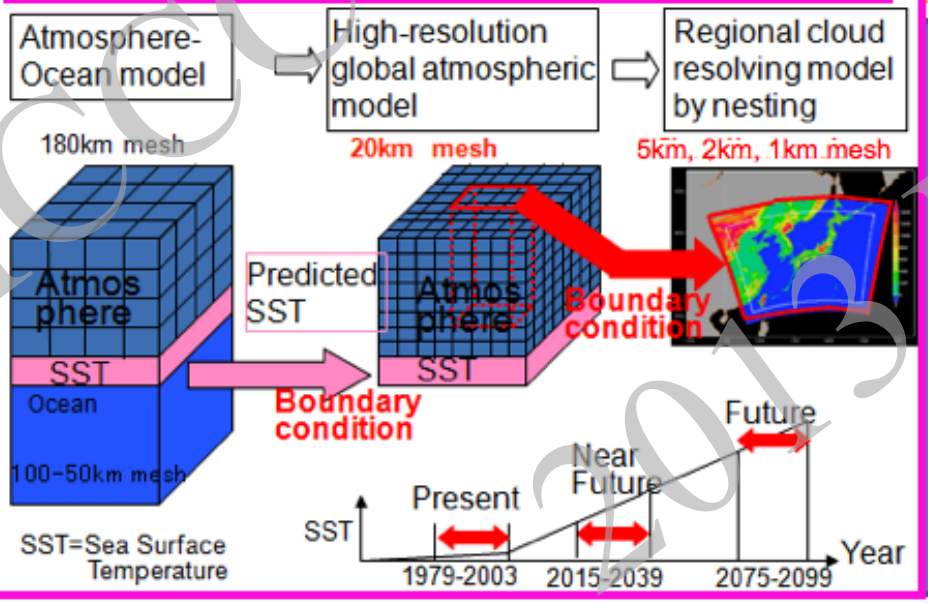


A2. Extreme Weather

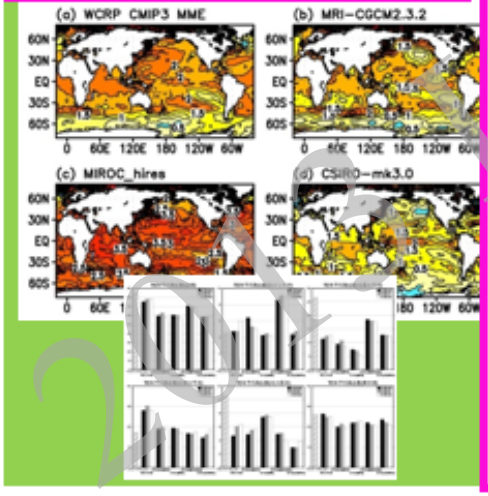




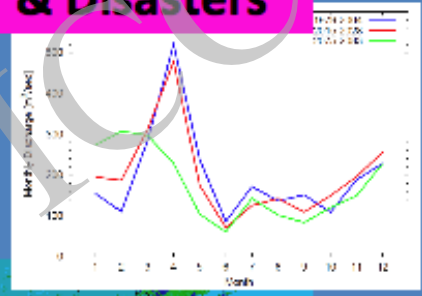
20km Global and 1-, 2- & 5-km Regional Models

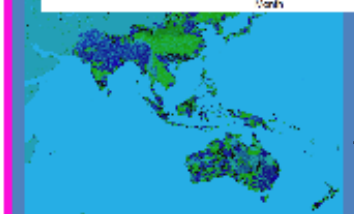


B. Uncertainty



C. Flood & Disasters





Prediction and evaluation of disaster environment in Japan

DPRI / Kyoto-Univ.

Slope Mountains River Habitable Area Coastal Area

Output from GCM and RCM

Hourly precipitation, temperature, water vapor, wind velocity, radiation and air pressure
（25-years time series (20km) and ensemble predictions (60km) for current, near future and century end）

Interpreta-tion of output

Regional climate model（RCM_5km, RCM_2km, RCM_1km）

Surface hydrological model

Stochastic typhoon model

Probability density function of extreme value（depending on spacio-temporal scales）
Stochastic precipitation model (time series depending on spacio-temporal scales)

Various Models（with long-term run）

Soil production

Reservoir operation

Soil runoff

Sedimentation and transportation of soil

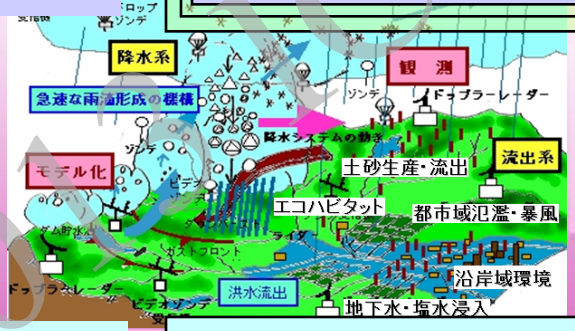
Rainfall runoff

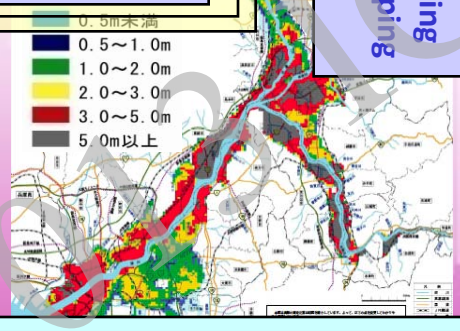
River channel flow

Inundation including underground shopping mole

Building damage by strong wind

Storm surge

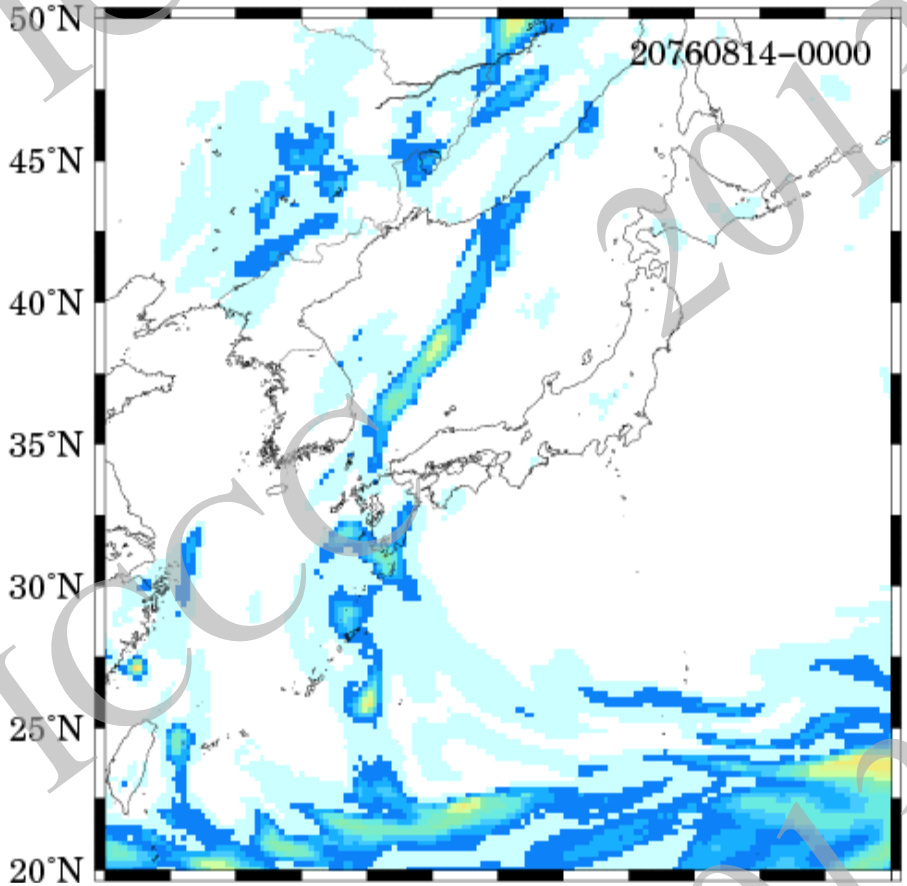




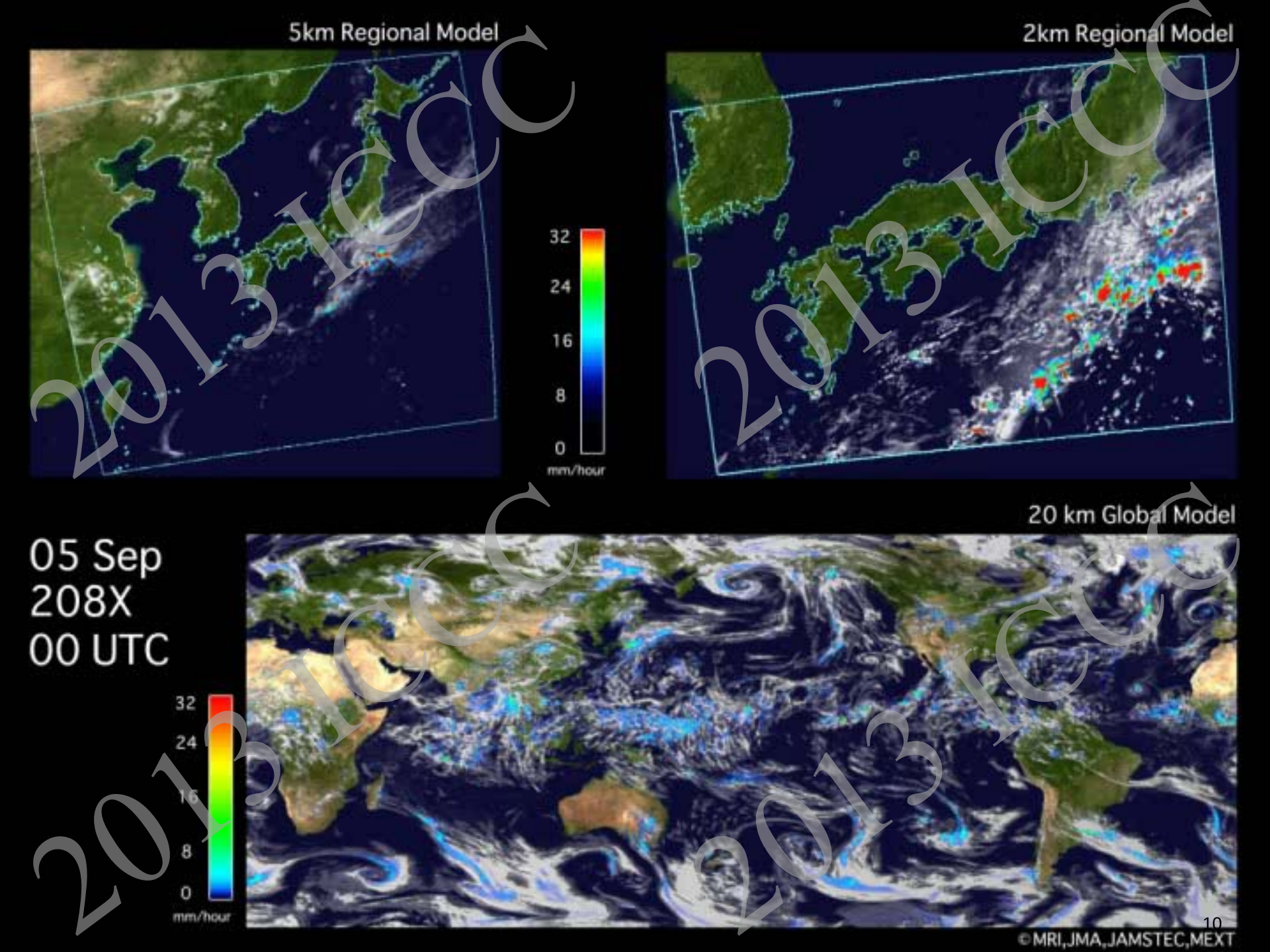
Evaluation

Decreasing of safety against landslide, debris flow, flood, draught, storm surge and strong wind .
Assessment of current protection system and proposal of alternatives

Projected typhoon by GCM20



It is the typhoon resolving output from GCM20 that has realized the impact assessment on Japanese river regime


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
2013ICCC
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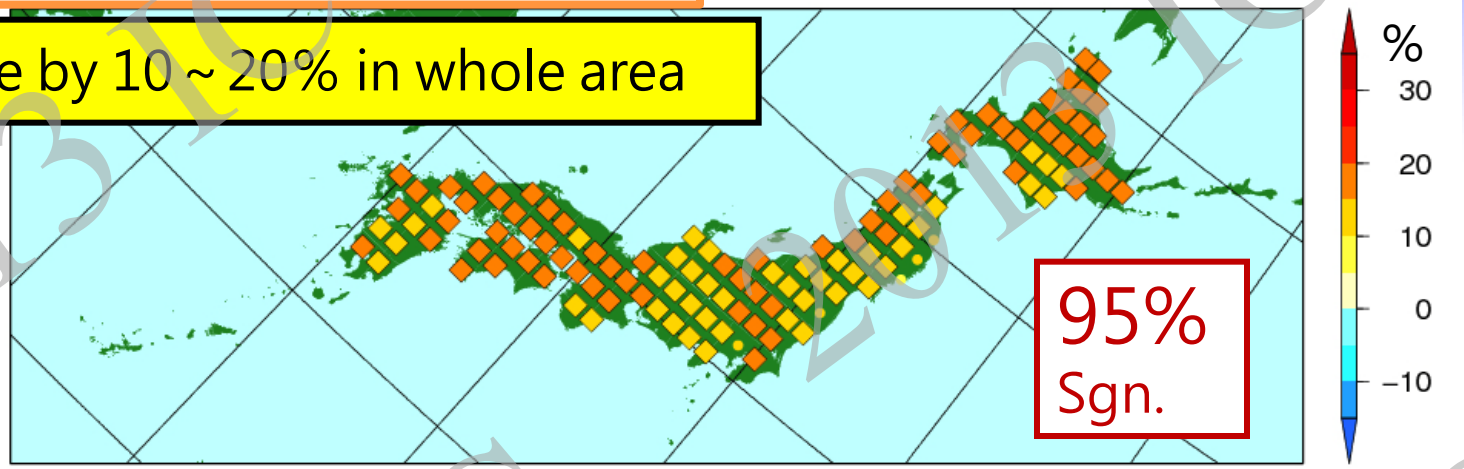
©MRI,JMA,JAMSTEC,MEXT

Increase in land slide risk

Fut. - Pres.

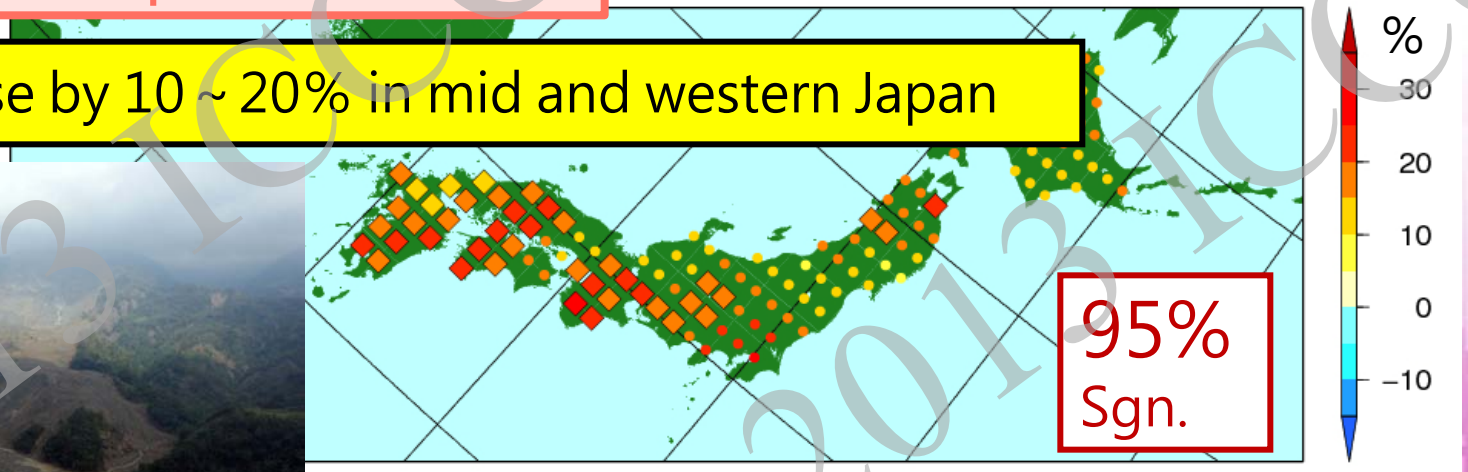
Risk of shallow land slide

Increase by 10 ~ 20% in whole area



Risk of deep land slide

Increase by 10 ~ 20% in mid and western Japan



Oku and Nakakita (2012)

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Design value

River discharge
Storm surge

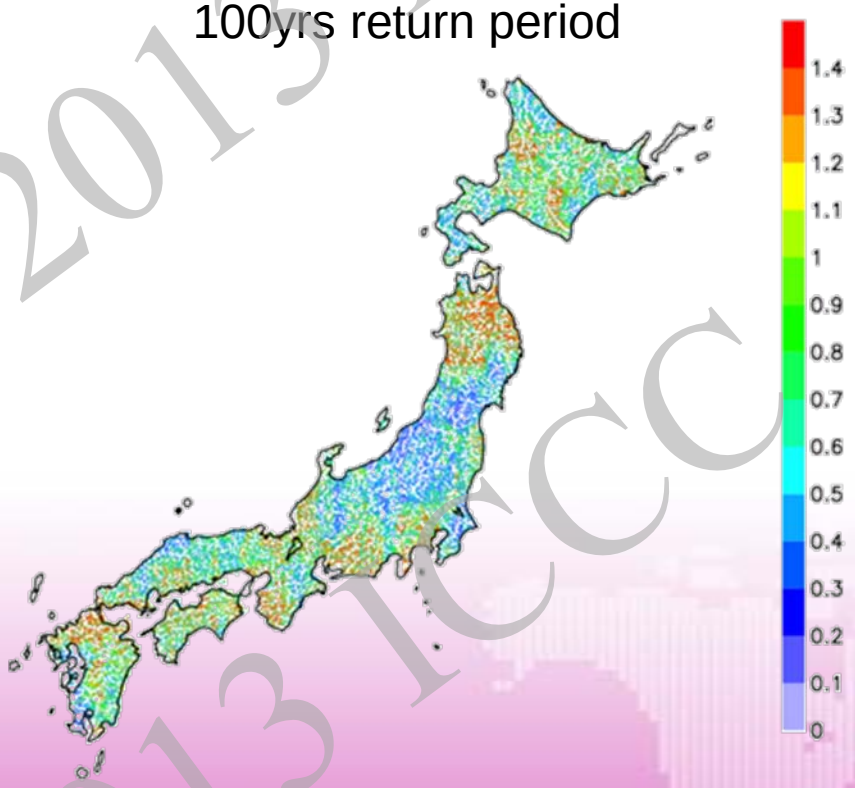
Design value
(Return period)

Range for disaster Mitigation

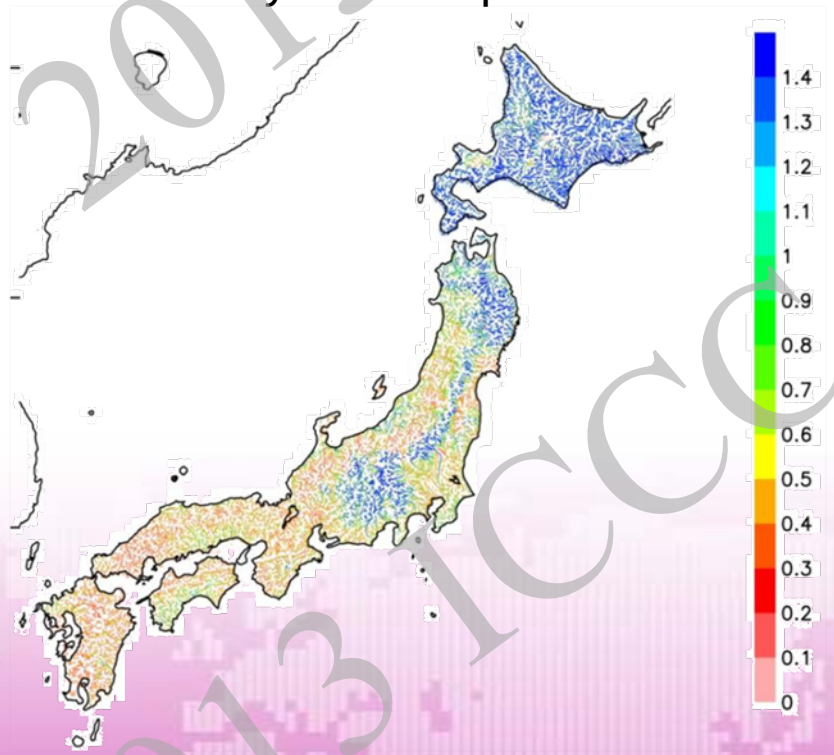
Range for disaster Prevention

River discharge

Flood flow change
(Q_1: Annual Maximum discharge)
100yrs return period



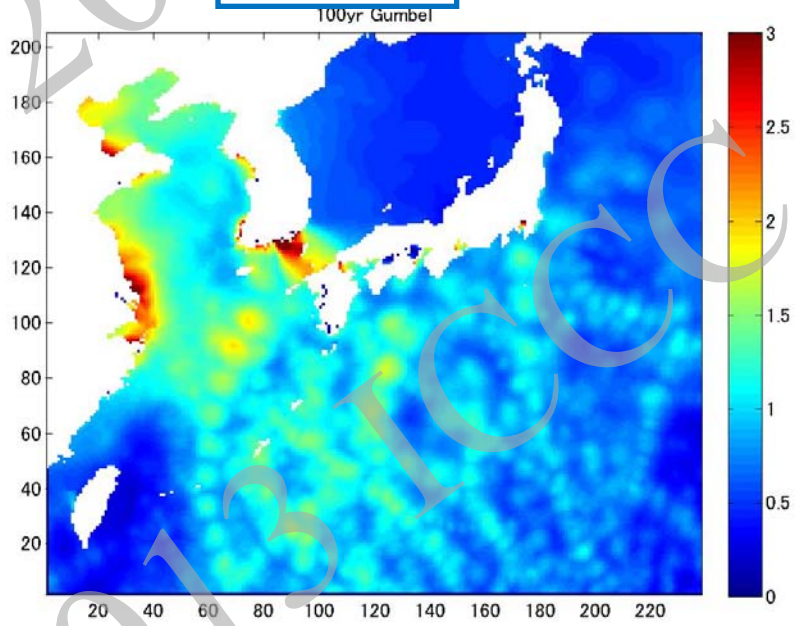
Draught flow change
(Q_{355} discharge)
10yrs return period



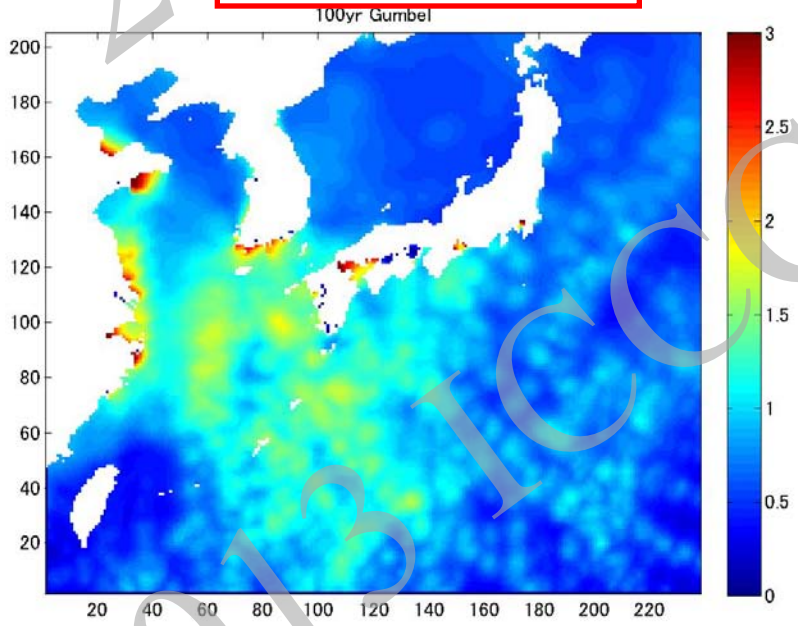
Tachikawa et al (2009)

100-years return values of Storm surge (deviation from the average year value)

Current

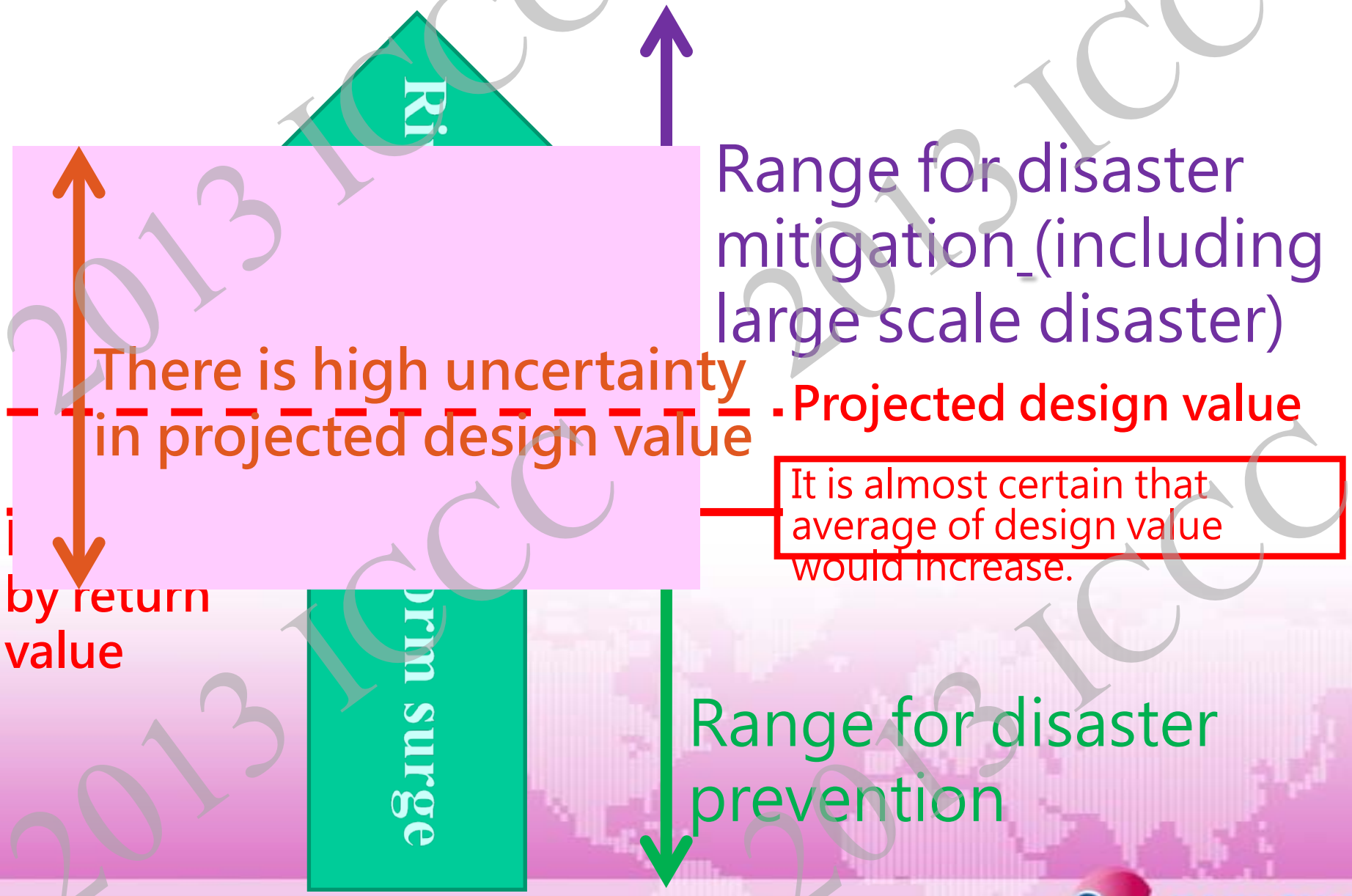


End of century



Mase, Mori and Yasuda G. (2011)

Heading to adaptation



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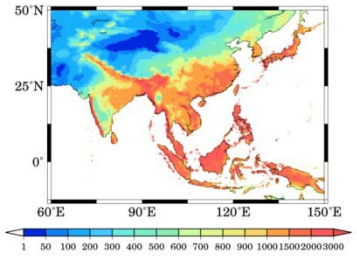
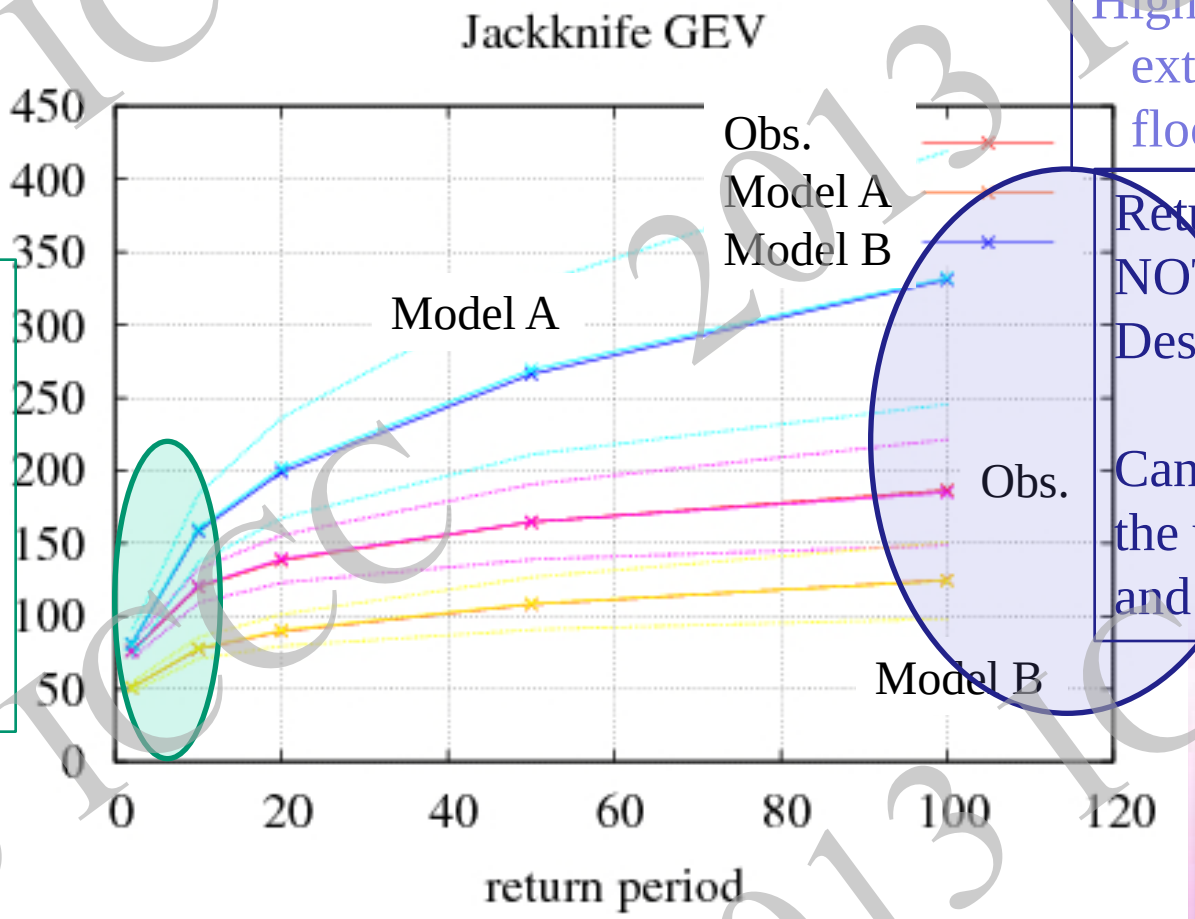


Schematic of return value's uncertainty

AMS



Low uncertainty: agriculture, water resources

Return value can be used as design level

High uncertainty: extreme events, flood, land slide

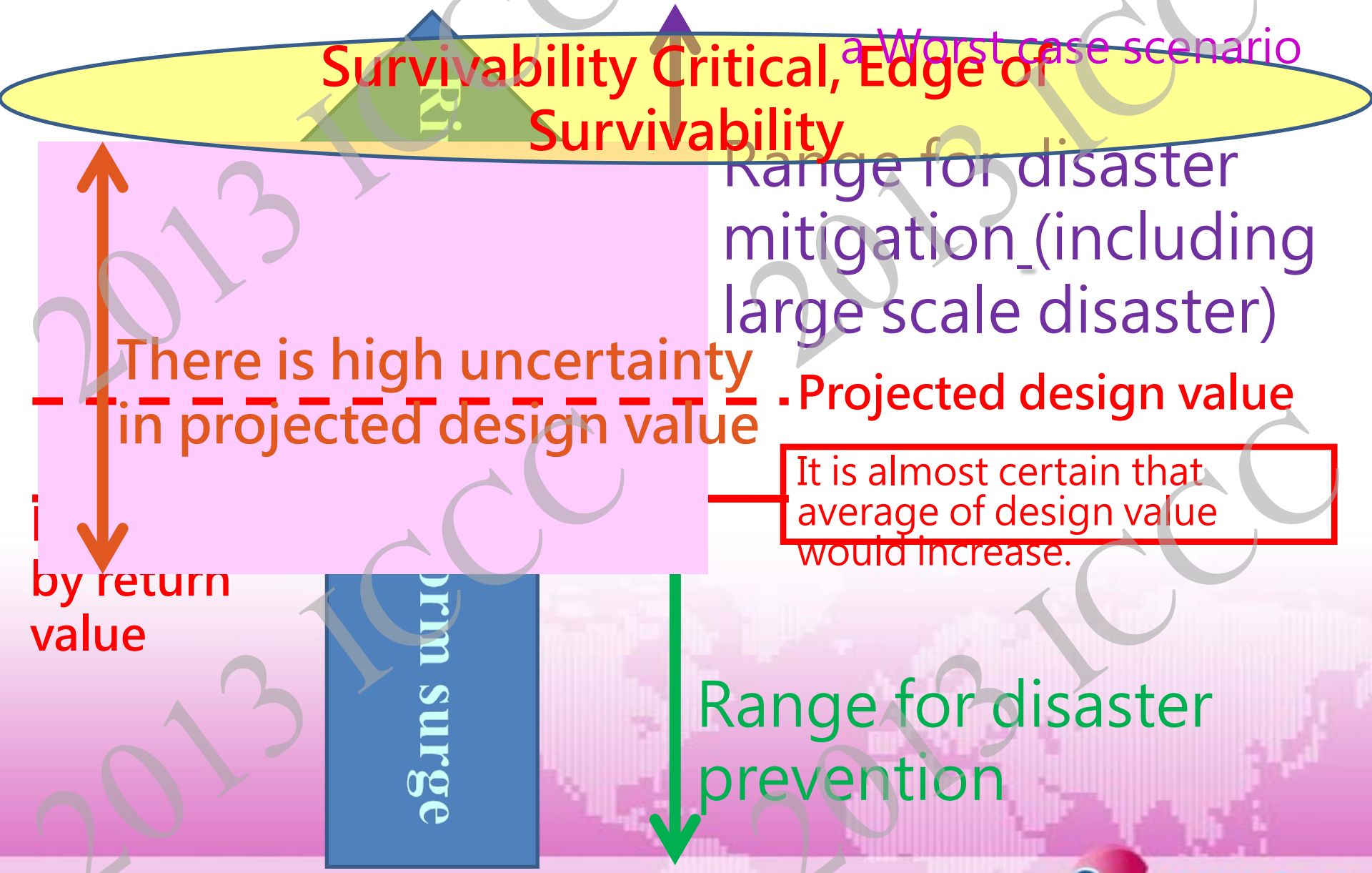
Return value can NOT be used as Design level

Can RCM reduce the uncertainty and bias?

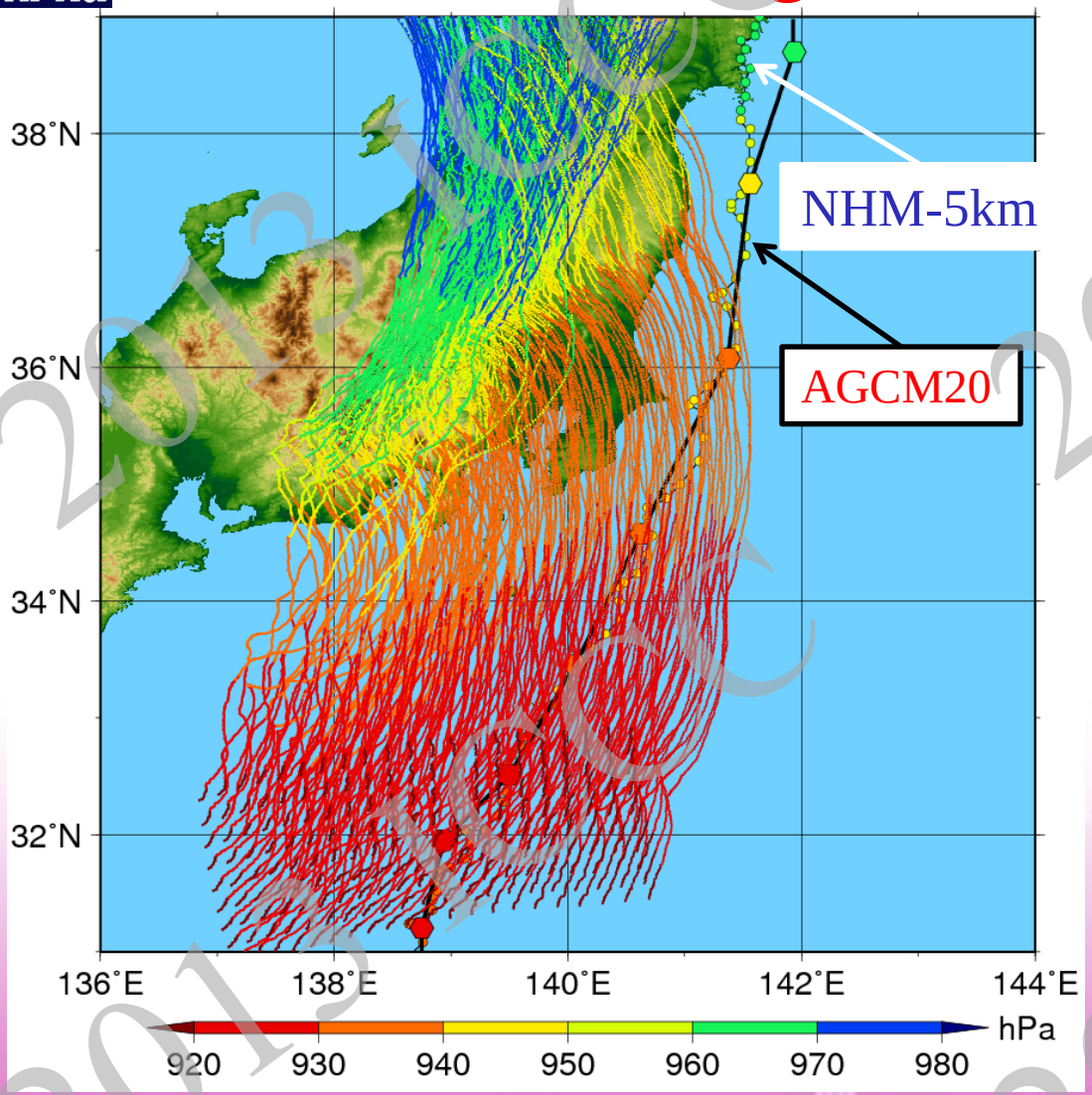
With 25-years single time series

Konoshima and Nakakita (2010)

Heading to adaptation



Virtual Shifting of typhoon's initial position - for making a worst scenario -



Virtual Shifting of typhoons initial position by keeping potential vorticity same (a vorgas method)

Dynamic downscale by RCM

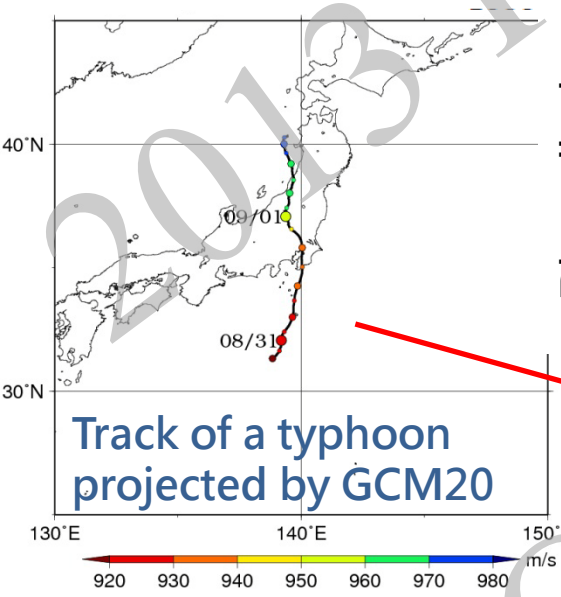
Worst case impact assessment on

- Land: extreme wind and rainfall
- Ocean: storm surge and wave height

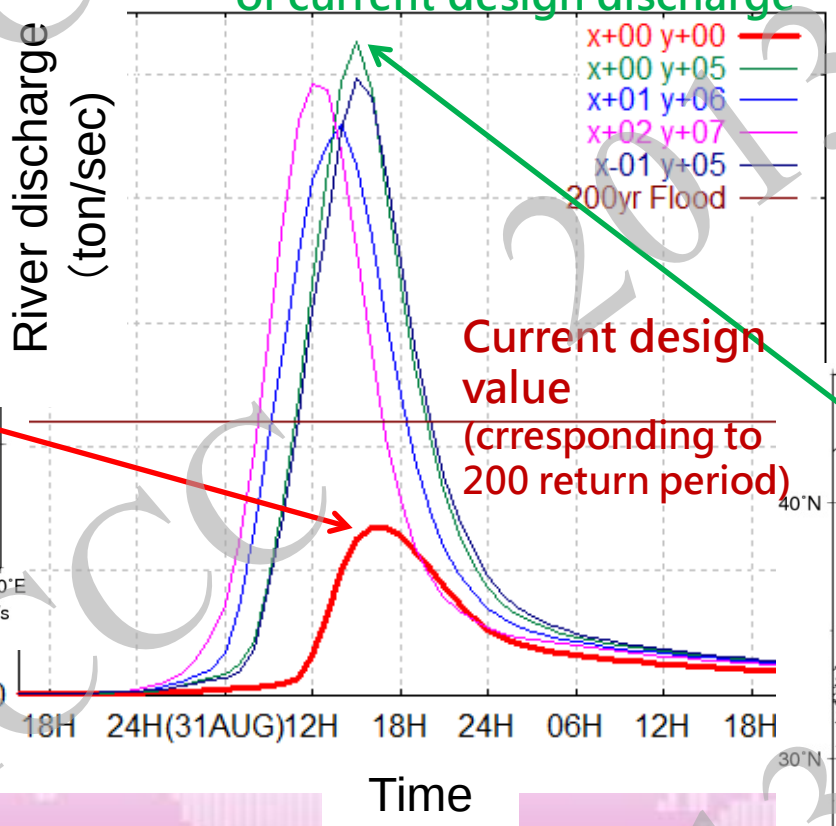
Ishikawa et al (2009)

River Discharge by the virtual shifting of typhoon which was projected by GCM

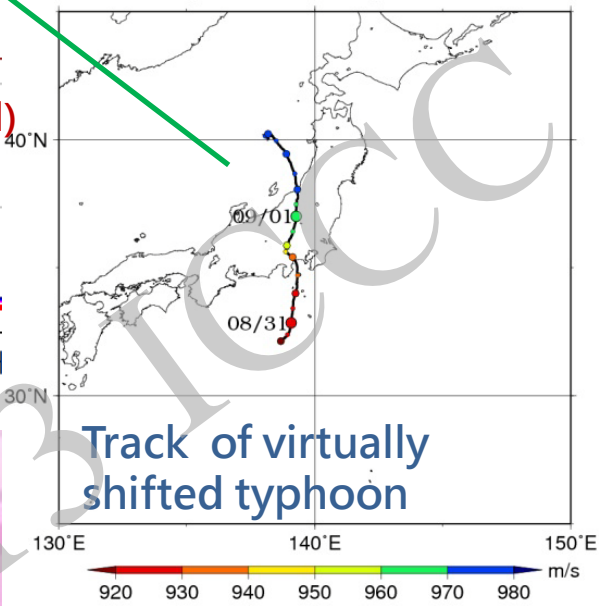
Possibility of peak discharge of almost double of current design discharge



Track of a typhoon projected by GCM20



Current design value (crresponding to 200 return period)



Track of virtually shifted typhoon

Oku et al (2009)

Heading to adaptation

Survivability Critical, Edge of Survivability

a Worst case scenario

We may need a new concept without using probability !!

isaster

including

large scale disaster)

There is high uncertainty in projected design value

Projected design value

It is almost certain that average of design value would increase.

by return value

Storm surge

Range for disaster prevention

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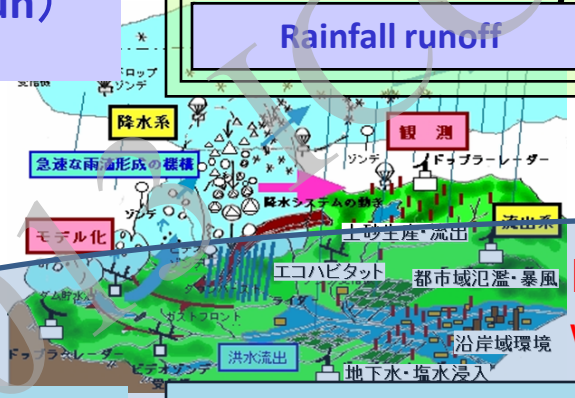
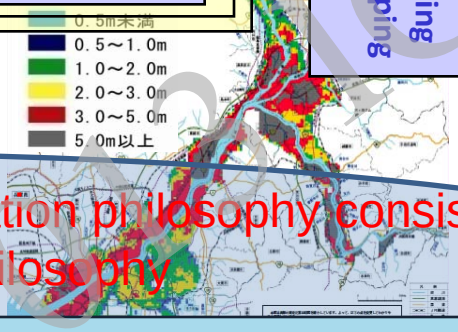




Proposing adaptation philosophy consistent with mitigation philosophy

Evaluation

Decreasing of safety against landslide, debris flow, flood, draught, storm surge and strong wind .
Assessment of current protection system and proposal of alternatives

DPRI-KU

ilosophy consistent
y

Key issues in SOUSEI

- Generating PDF of extreme values with higher accuracy
  - Generating of PDF using a lot of 60km ensemble
  - Converting extreme values in 60km-scale into values in regional-scale using RCM5 and RCM2 daynamically dounscaled from GSM20.
- Proposing adaptation philosophy consistent with mitigation philosophy
  - Developing decision making methodology under high uncertainty of risk
  - Developing decision making methodology under no information on probability of a worst case

Groups in SOUSEI Program (Program for Risk Information on Climate Change)

- A: **Prediction and diagnosis of imminent global climate change (Kimoto, Univ. of Tokyo)**
- B: **Climate change projection contributing to stabilization target setting (Kawamiya, JAMSTEC)**
- C: **Development of Basic Technology for Risk Information on Climate Change (Takayabu, MRI)**
- D: **Precise impact assessments on climate change (Nakakita, Kyoto Univ.)**

A: Prediction and diagnosis of imminent global climate change (Kimoto, AORI, University of Tokyo)

- Understanding mechanisms of climate variability and change
- Development of an integrated prediction system for global climate studies

B: Climate change projection contributing to stabilization target setting (Kawamiya, JAMSTEC)

- Long-term global change projection based on diverse scenarios
- Obtaining scientific perceptions on large-scale variations and modifications of climate

Groups in SOUSEI Program (Program for Risk Information on Climate Change)

- A: **Prediction and diagnosis of imminent global climate change (Kimoto, Univ. of Tokyo)**
- B: **Climate change projection contributing to stabilization target setting (Kawamiya, JAMSTEC)**
- C: **Development of Basic Technology for Risk Information on Climate Change (Takayabu, MRI)**
- D: **Precise impact assessments on climate change (Nakakita, Kyoto Univ.)**

C: Development of Basic Technology for Risk Information on Climate Change (PI:Takayabu, Meteorological Research Institute)

- Probabilistic climate projection for risk assessment
- Producing a standard climate scenario by using super high resolution models

Theme C leader: I. Takayabu (MRI)

Development of Basic Technology for Risk Information on Climate Change

(i) Probabilistic climate projection for risk assessment

NIED (Dr. Dairaku)

(a) Efficient approach for climate ensemble experiment (NIED)
(b) Development of Statistical Methodology of Ensemble Data on Climate Change (ISM)
(c) Improvement in Cost-Efficiency of Dynamical Downscaling for Ensemble Data (AORI)

(ii) Producing a standard climate scenario by using super high resolution models

MRI (Dr. Takayabu)

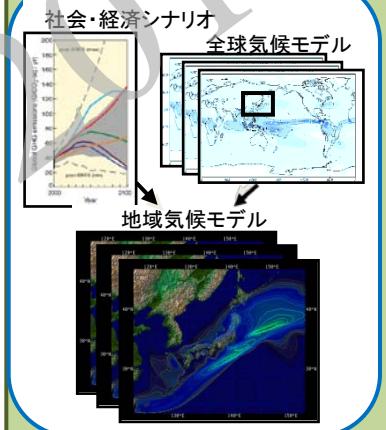
(a) Development of quantification method for reliability and uncertainty of climate change information (Univ. of Tsukuba)
(b) Downscaling of the change in future weather extremes by using high-resolution models (MRI)
(c) Development of a Coupled Ocean-Atmosphere Non-hydrostatic Model for Typhoon Research (HyARC)

Theme C leader: I. Takayabu (MRI)

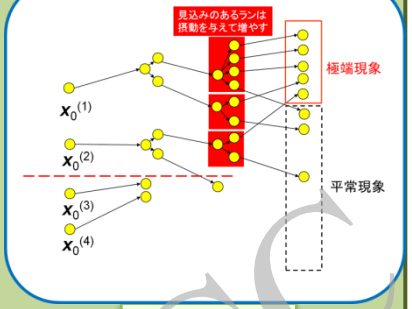
Development of Basic Technology for Risk Information on Climate Change

(i) Probabilistic climate projection for risk assessment

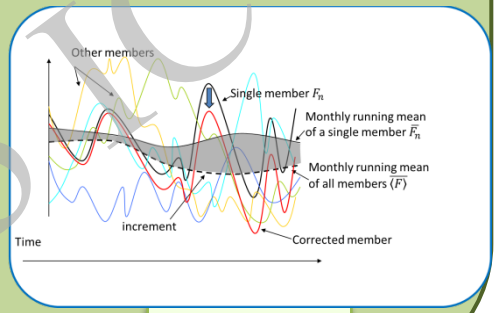
NIED (Dr. Dairaku)



(a) NIED



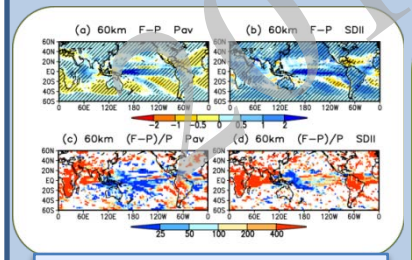
(b) ISM



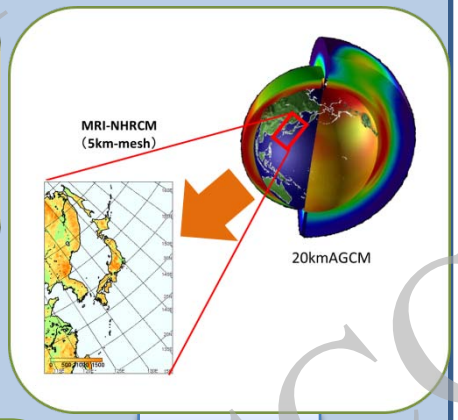
(c) AORI

(ii) Producing a standard climate scenario by using super high resolution models

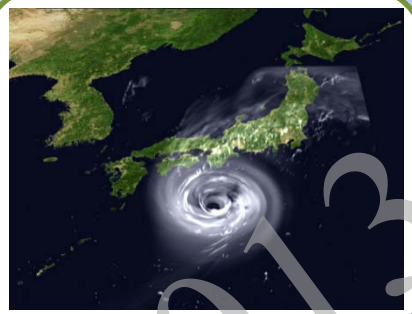
MRI (Dr. Takayabu)



(a) Univ. of Tsukuba

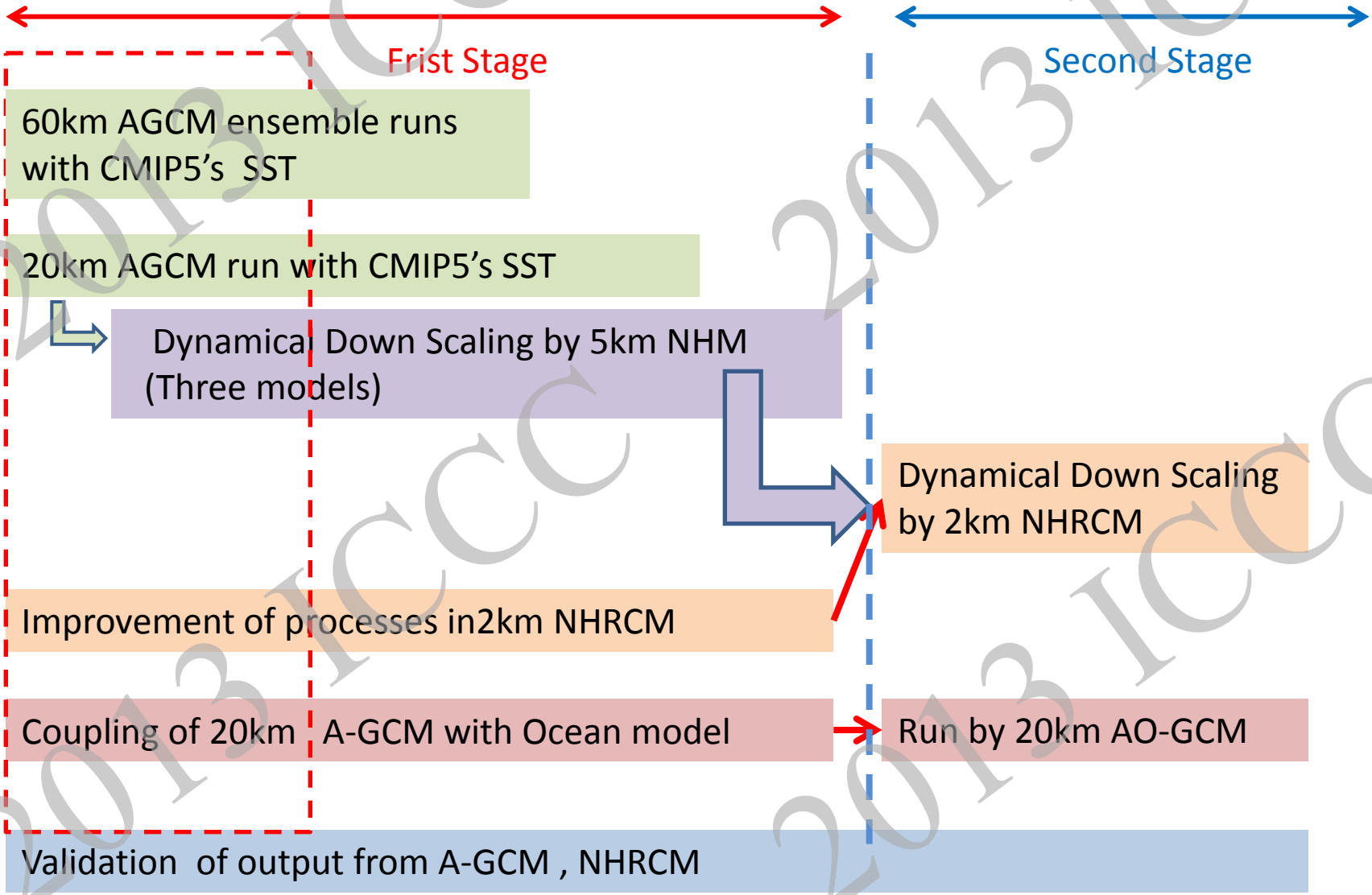


(b) MRI



(c) HyARC

Computation with GCM and RCM



D: Development of Basic Technology for Risk Information on Climate Change (Nakakita, DPRI, Kyoto University)

- Climate change impacts on natural hazards
- Climate change impacts on water resources
- Climate change impacts on ecosystem and biodiversity

Precise impact assessments on climate change (PI: E. Nakakita, KU (Kyoto University))

- i. Climate change impacts on natural hazards (E. Nakakita, KU)
  - i-a Risk assessment of meteorological disasters under climate change (T. Takemi, KU)
  - i-b Risk assessment of water-related disasters under climate change (Y. Tachikawa, KU)
  - i-c Risk assessment of coastal disasters under climate change (N.Mori, Kyoto U)
  - i-d Measuring socio-economic impacts of climate change and effectiveness of adaptation strategies (H. Tatano, KU)
  - i-e Development of risk assessment and adaptation strategies for water-related disaster in Asia (S. Tanaka, ICHARM, PWRI)
- ii. Climate change impacts on water resources (K. Tanaka, KU)
  - ii-a Assessment of socio-economic impacts on water resources and their uncertainties under changing climate (K. Tanaka, KU)
  - ii-b Assessment of climate change impacts on the social-ecological systems of water resources and hydrological cycles (T. Oki, UT)
- iii. Climate change impacts on ecosystem and biodiversity (T. Nakashizuka, TU)
  - iii-a Assessment of climatic impacts on ecosystem and biodiversity (T. Nakashizuka, TU)
  - iii-b Economic evaluation of ecosystem service (S. Managi, TU)
  - iii-c Eco-climate system in Northeastern Eurasia and Southeast Asian tropics: impacts of global climate change (T. Kumagai, NU)
  - iii-d Assessment of multiple effects of climate change on coastal marine ecosystem (Y. Yamanaka, HU)

Prediction and evaluation of disaster environment in Japan

DPRI / Kyoto-Univ.

Slope　Mountains　River　Habitable Area　Coastal Area

Output from GCM and RCM

Hourly precipitation, temperature, water vapor, wind velocity, radiation and air pressure
（25-years time series (20km) and ensemble predictions (60km) for current, near future and century end）

Interpreta-tion of output

Regional climate model（RCM_5km, RCM_2km, RCM_1km)

Surface hydrological model

Stochastic typhoon model

Probability density function of extreme value（depending on spacio-temporal scales）
Stochastic precipitation model (time series depending on spacio-temporal scales)

Various Models（with long-term run）

Soil production

Reservoir operation

Soil runoff

Sedimentation and transportation of soil

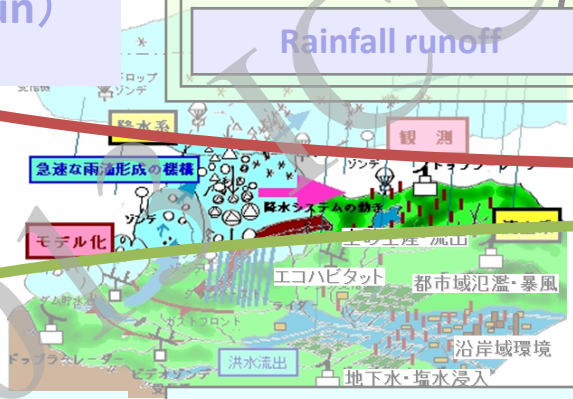
Rainfall runoff

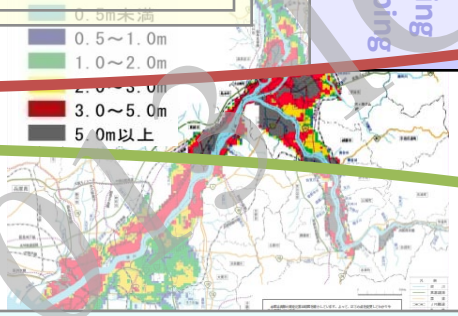
River channel flow

Inundation including underground shopping mole

Building damage by strong wind

Storm surge





Evaluation

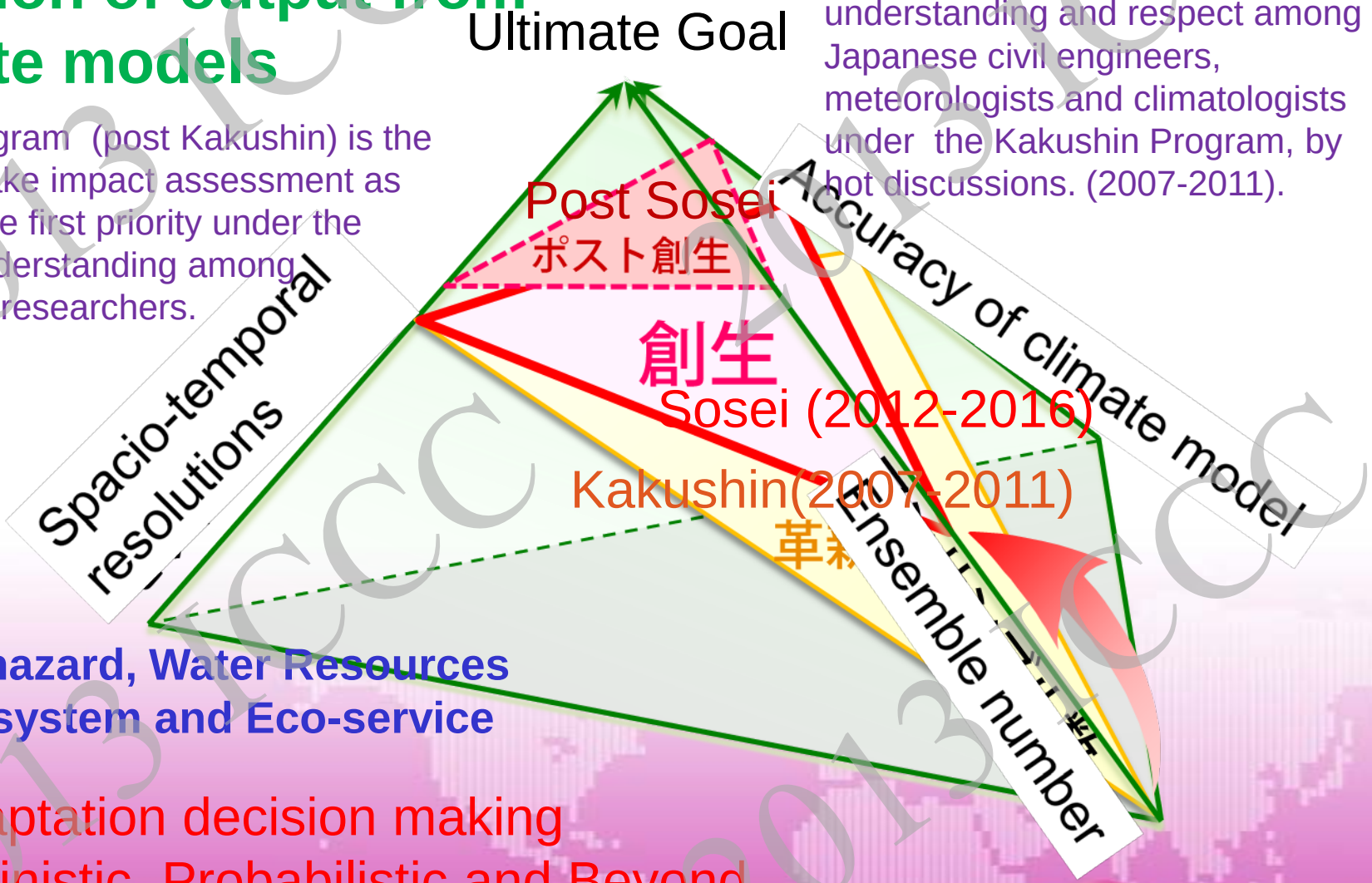
Decreasing of safety against landslide, debris flow, flood, draught, storm surge and strong wind .
Assessment of current protection system and proposal of alternatives

Sousei (創生) Program (2012-2016)

Situation of output from Climate models

Sosei Program (post Kakushin) is the stage to take impact assessment as issue of the first priority under the mutual understanding among Japanese researchers.

We have been harvesting mutual understanding and respect among Japanese civil engineers, meteorologists and climatologists under the Kakushin Program, by hot discussions. (2007-2011).

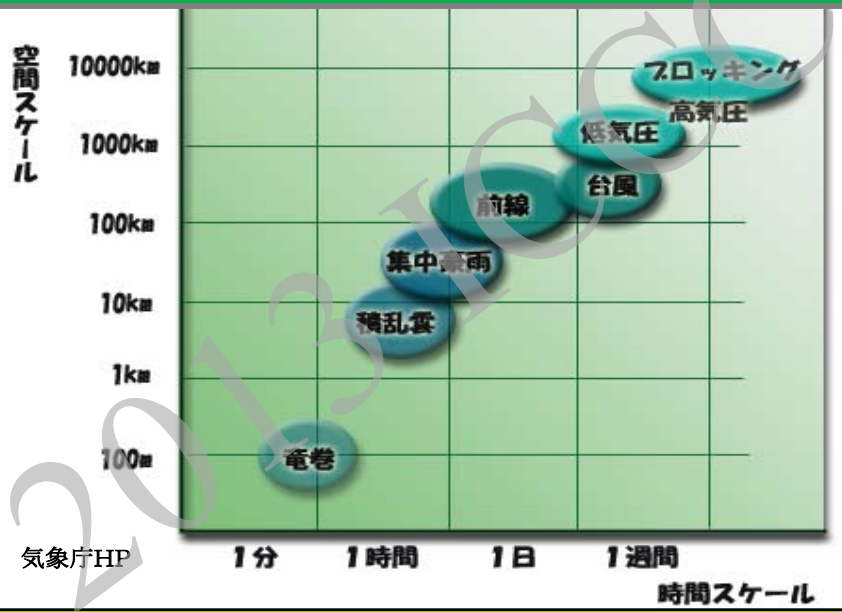


Topics:
Natural hazard, Water Resources and Ecosystem and Eco-service

For adaptation decision making
Deterministic, Probabilistic and Beyond


01 Sep 208X 00 UTC
2013 ICCC
2013 ICCC
2013 ICCC
2013 ICCC
©MRI,JMA,JAMSTEC,MEXT

Spacio-temporal scale

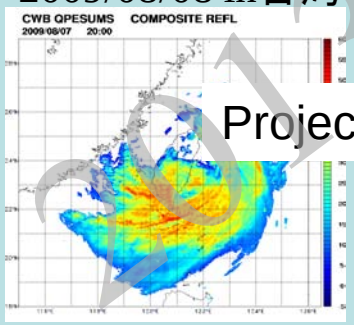


気象庁HP

Typhoon

Range : 1000km
Duration : 1 day to a few days

大河川での洪水、大規模水害、土砂災害
2009/08/08 in台湾



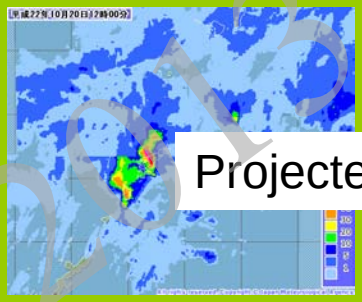
Projected by AGCM20

台湾中央気象局、台湾国家災害防救科技中心

Localized heavy rainfall (Baiu season)

Range : 100km
Duration : 6 hours to half a day

中・小河川での洪水、内水氾濫、土砂災害
2010/10/20 in奄美



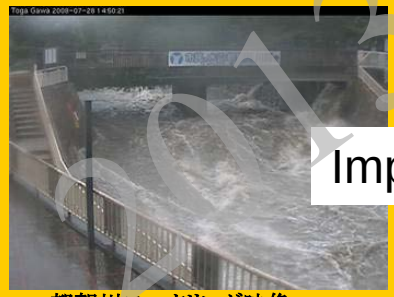
Projected by RCM

南日本新聞 OFFICIAL SITE

Shower

Range : 10 km
Duration : about half an hour

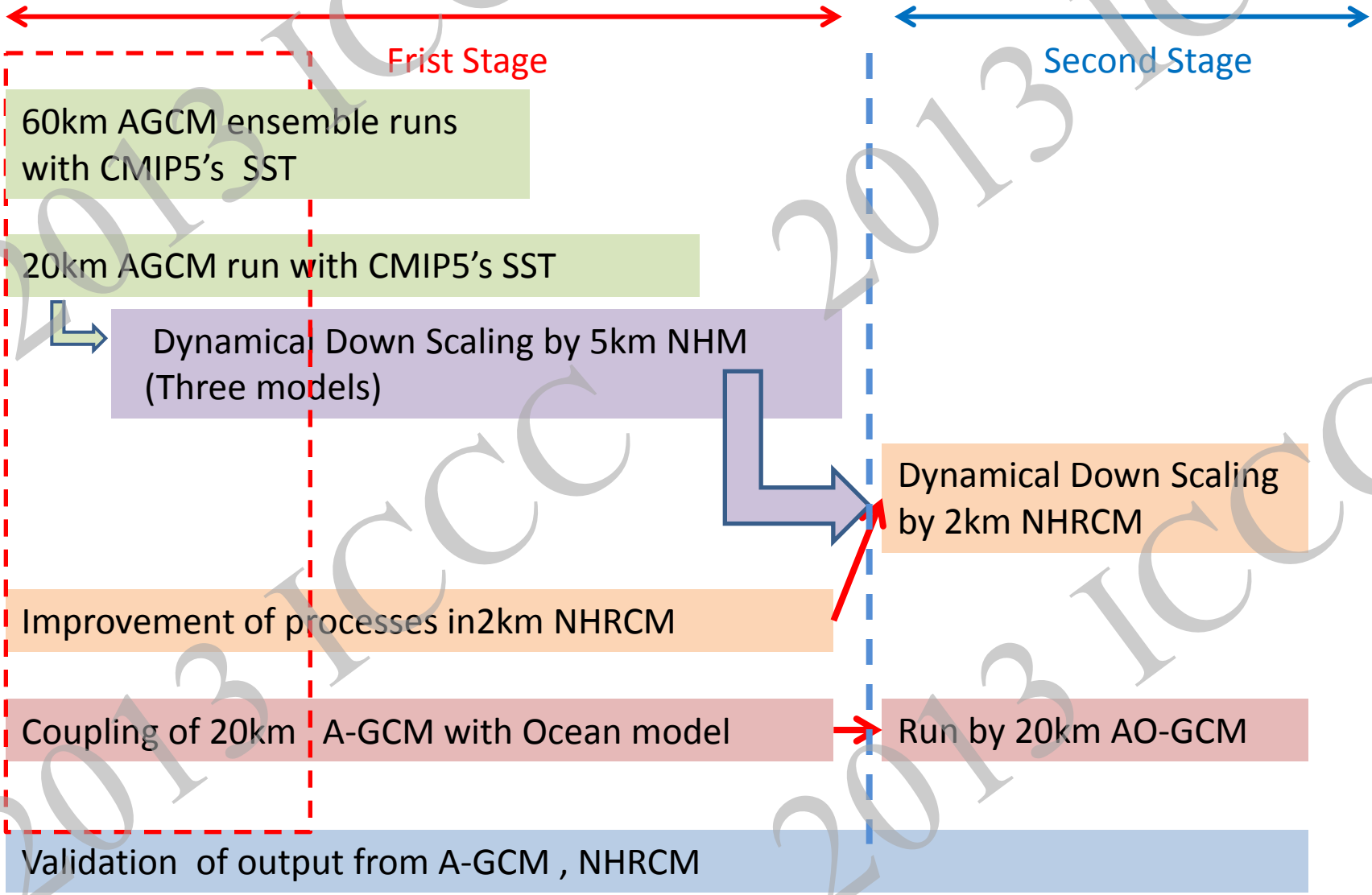
小河川や下水道内での鉄砲水、都市内水氾濫
2008/07/28 at都賀川　2008/08/05 at雑司ヶ谷



Impossible?

都賀川モニタリング映像　共同通信

Computation with GCM and RCM



SOSEI PROGRAM (2012-2016)
PROGRAM FOR RISK INFORMATION ON CLIMATE CHANGE (予算の質問のため、参考のためにつけておきます

- Climate change program by MEXT
  - 2002-2006 Kyosei program
  - 2007-2011 Kakushin program
  - 2012-2016 Sosei program
- Sosei program group
  - A. Projection of climate variability (Kimoto, Utokyo) 1.4
  - B. Projection of climate change (Kawamiya, JAMSTEC) 1.4
  - C. Projection of climate risk (Takayabu, MRI) 1.4
  - D. Projection of climate effects and adaptation (Nakakita, Kyoto U) 1.8
  - E. Exchange among climate groups and researchers

Summary (1)

1. **The AGCM and RCM with super-high spatio-temporal resolutions (20 km-1 hour) made it possible to evaluate extreme hazard (ex. Max. discharge) in Japan.**
3. **We can get approximate projection on changes of return values of extreme events.**
4. **However, there is a risk that the return period does not have enough accuracy because there is no guarantee that quite extreme events could be properly projected within the limited number of ensembles. (Single time series output from the AGCM20 and RCM)**
5. **In this sense, it may be difficult to project correct design hazard for water management and flood control so on.**

Summary (2)

6. On the other hand, the risk management deal with phenomena beyond design hazards. In this sense, it is very important to take into account the result from a worst case scenario as one of the forcing hazard for disaster risk management under climate change.
7. 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.
8. Of cause, making the number of ensembles increase is essential for the Kakushin follow-up program.

D-i: Climate change impacts on natural hazards

- Risk assessment of meteorological, water related, and coastal disasters under climate change (Kyoto Univ.)
- Measuring socio-economic impacts of climate change and effectiveness of adaptation strategies (Kyoto Univ.)
- Development of risk assessment and adaptation strategies for water-related disaster in Asia (PWRI)

D-ii: Climate change impacts on water resources

- Assessment of socio-economic impacts on water resources and their uncertainties under changing climate (Kyoto Univ.)
- Assessment of climate change impacts on the social-ecological systems of water resources and hydrological cycles (Univ. of Tokyo)

D-iii: Climate change impacts on ecosystem and biodiversity

- Assessment of climatic impacts on ecosystem and biodiversity (Tohoku Univ.)
- Economic evaluation of ecosystem service (Tohoku Univ.)
- Eco-climate system in Northeastern Eurasia and Southeast Asian tropics (Nagoya Univ.)
- Assessment of multiple effects of climate change on coastal marine ecosystem (Hokkaido Univ.)