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2013 International Conference on Climate Change

Introduction on Taiwan Climate Change Projection and Information Platform (TCCIP) Project – from Technology and Data Service to Application

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2013,1,15

Outline

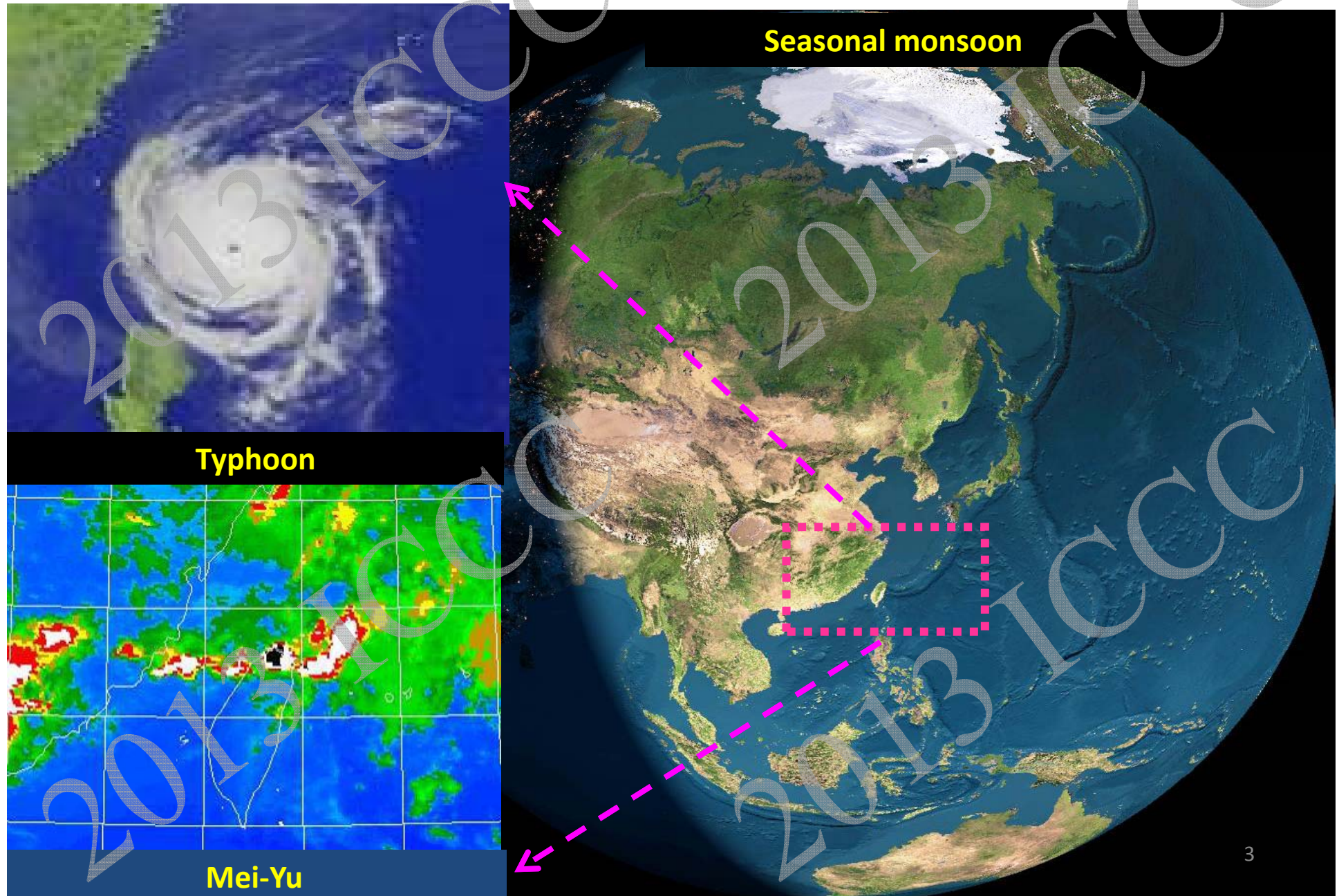
Introduction –The role of TCCIP

Achievement of TCCIP – an overview

Application of TCCIP – on water-related disasters

Summary

Introduction

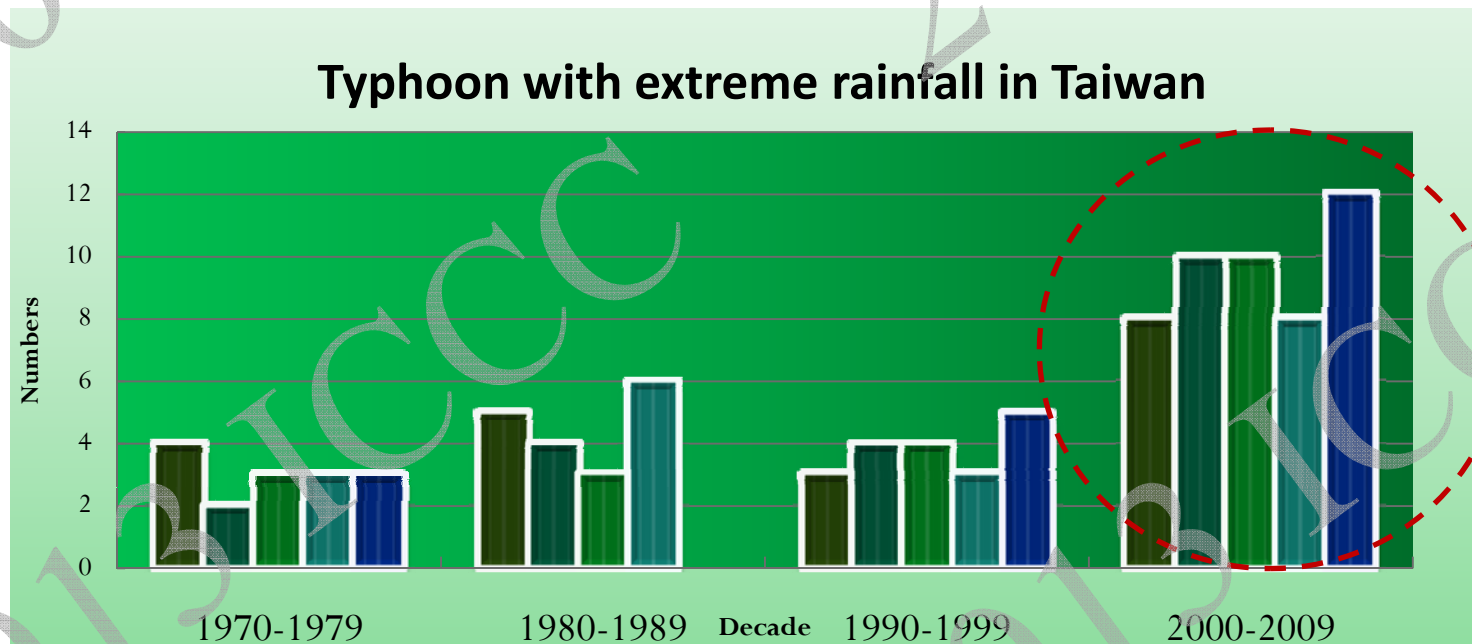


Too much or too little of water In Taiwan ?

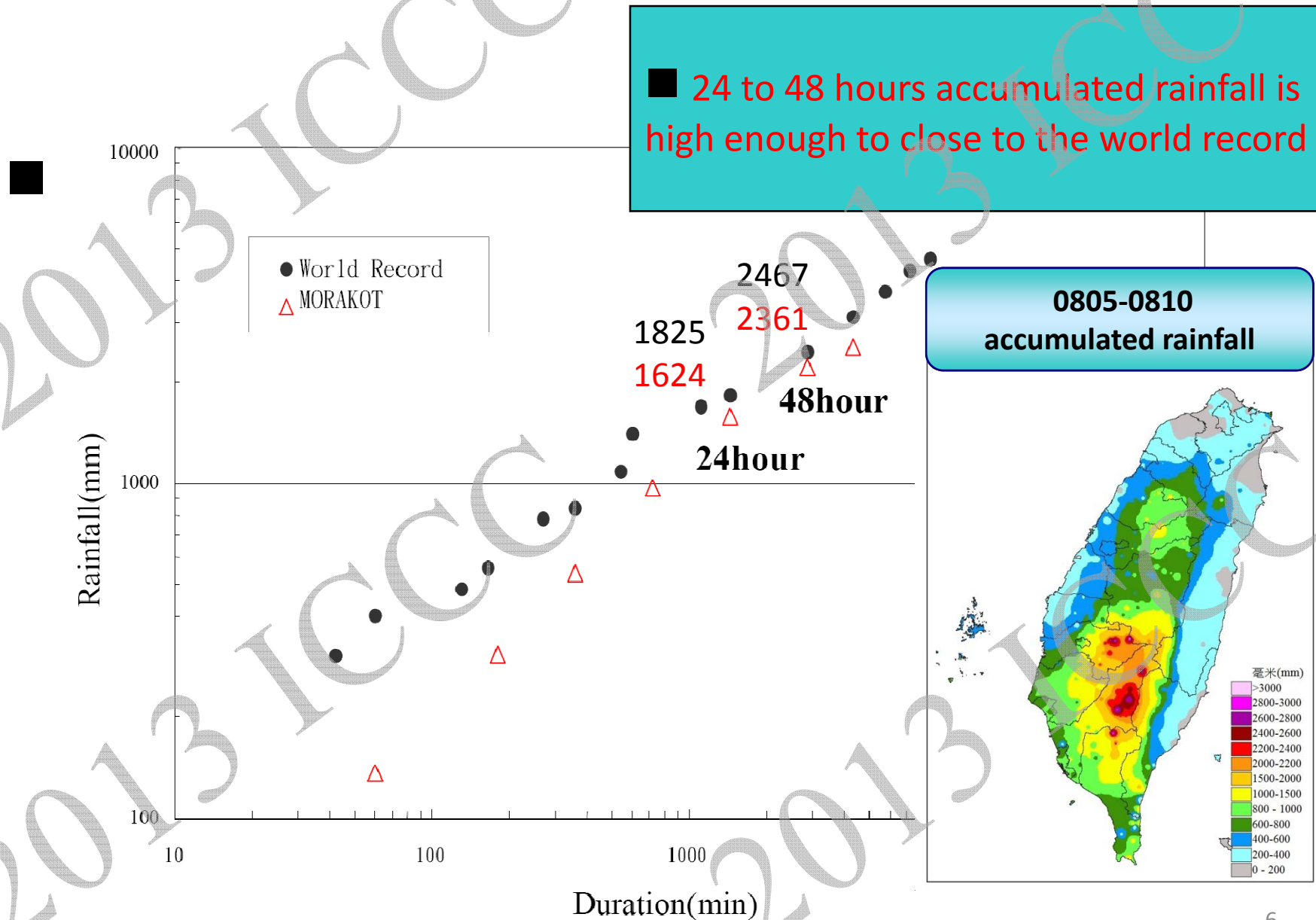
- In recent years, heavy rainfall caused by Typhoon, Mei-yu and Monsoon bring severe damages and casualties. It is a problem of “**too much of water.**”
- On the other hand, drought problem threatens livelihoods of people, agricultural activities and industry productions, because of uneven distribution of rainfall. It is a problem of “**too little of water.**”
- Now, we are facing a new big challenge, worsened disaster risk and exposure caused by climate change.
- **The extreme cases are not only scenarios, but our obligation to figure out the possible solutions**

Typhoon with extreme rainfall

- **The increase of extreme events** is evident in recent 10 years.

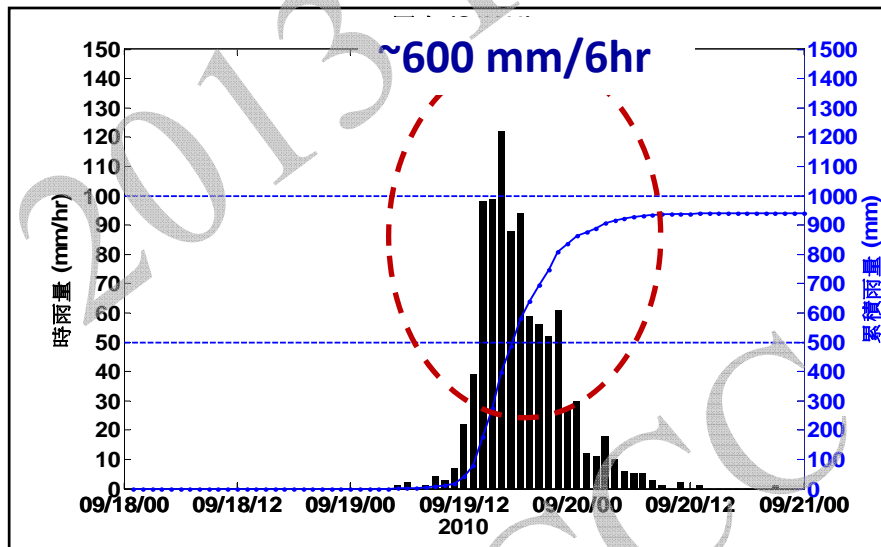


More and More Extreme Events in Taiwan ?



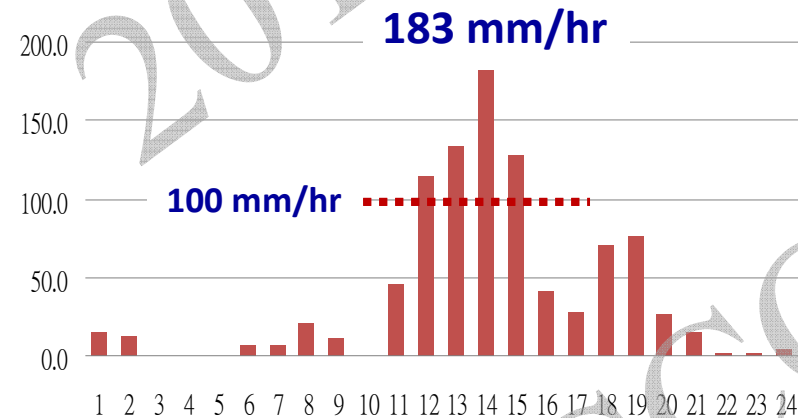
More and More Extreme Events in Taiwan ?

Typhoon Fanapi (2010)



Typhoon Megi (2010)

2010.10.21 Suao station hourly rainfall



More and More Extreme Events in Taiwan ?

- From the cases I mention, there are some possible linkages between **extreme rainfall cases** and **climate change**. But we need more concrete study to identify the causing factors and ways for reduce future impact.
- Therefore, we hope to build up **scenario based and scientific methods** to provide the projections of future trends to governmental agencies or other users as reference for decision making.

Introduction –The role of TCCIP

What's TCCIP

- A scientific project of climate change research in Taiwan.
 - Downscale global CC projection data(AR4) to Taiwan area.
 - Local CC and it's impact research(EX: flood and drought).
 - Taiwan CC information application and data services.
 - Phase 1: 2010~2012.
 - Funded by NSC, Taiwan (~ 3 million USDS).
 - Interdisciplinary cooperated : 2 research institutes, 2 governmental departments, 3 universities are included.

Structure of TCCIP Project



International Cooperation

• **KAKUSHIN program, Japan**

High-resolution (20km) Climate Simulation

(Climate Projection for IPCC AR4)

Present : 1979-2003

Near Future : 2015-2039

End-of-century : 2075-2099

• **IPCC data analysis**

Application

Disaster Reduction

Land Use Planning

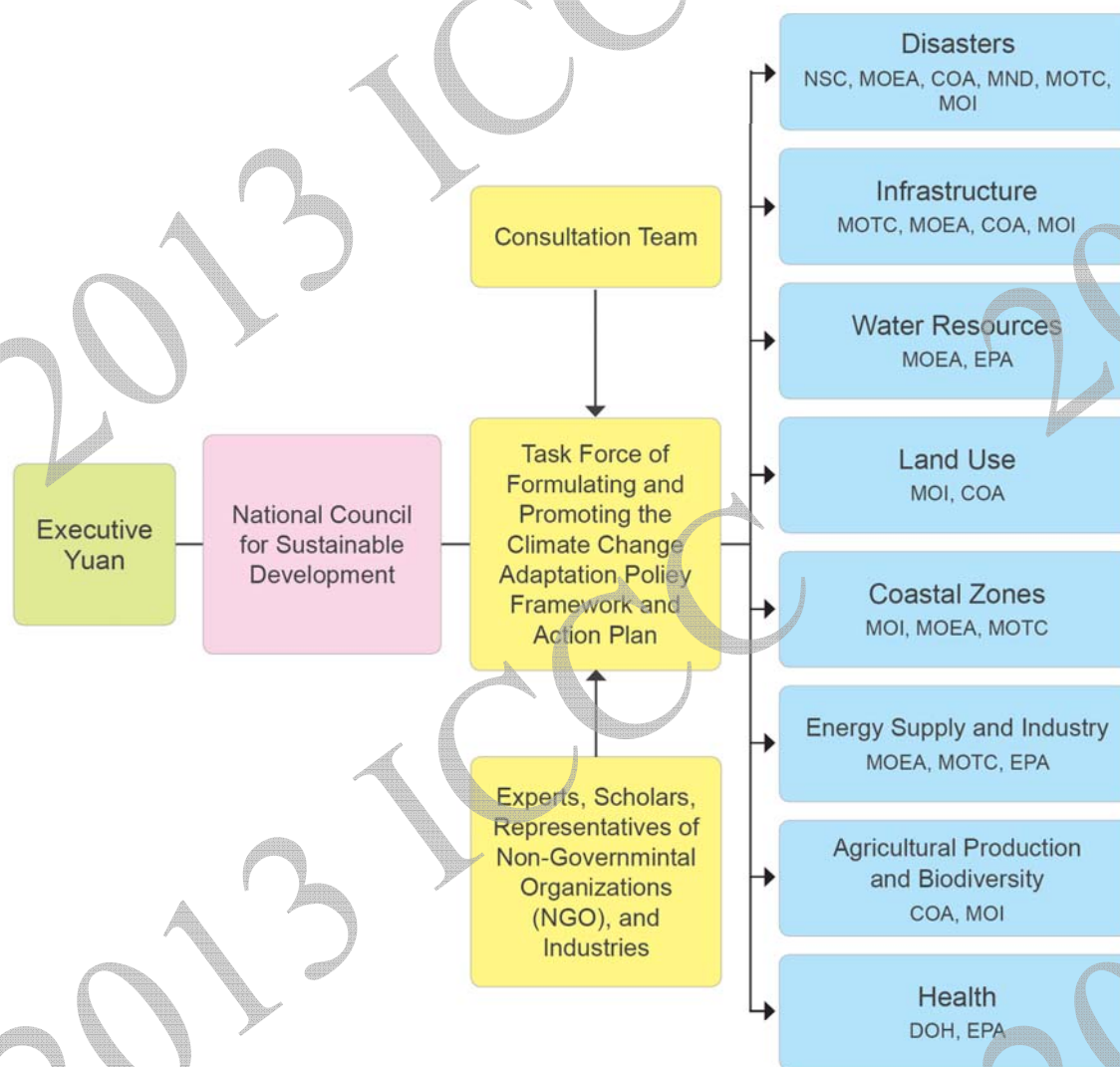
Water Resources Management

Agriculture

Environment & Ecosystem

Public Health

Adaptation Policy Framework(APF) for Climate Change at National Level



The Organization of the National Adaptation Policy Framework

1. The Working Group is jointly led by the Environmental Protection Agency (EPA) and the Council for Economic Planning and Development (CEPD).
2. A Task Force for Formulating and Promoting the Climate Change Adaptation Policy Framework and Action Plan was established.
3. CEPD has defined eight sectors under the Task Force.
4. More than one of the ministries and councils work together cooperatively in order to implement each sector's adaptation policies.

Science Project of Climate Change in Taiwan

Consortium for Climate Change Study (CCliCS)

Modeling Capacity Building

Period: 2011-2016



Taiwan Climate Change Information Platform (TCCIP)

Taiwan Climate Change
Assessment

Period: 2010-2012, 2012-2015

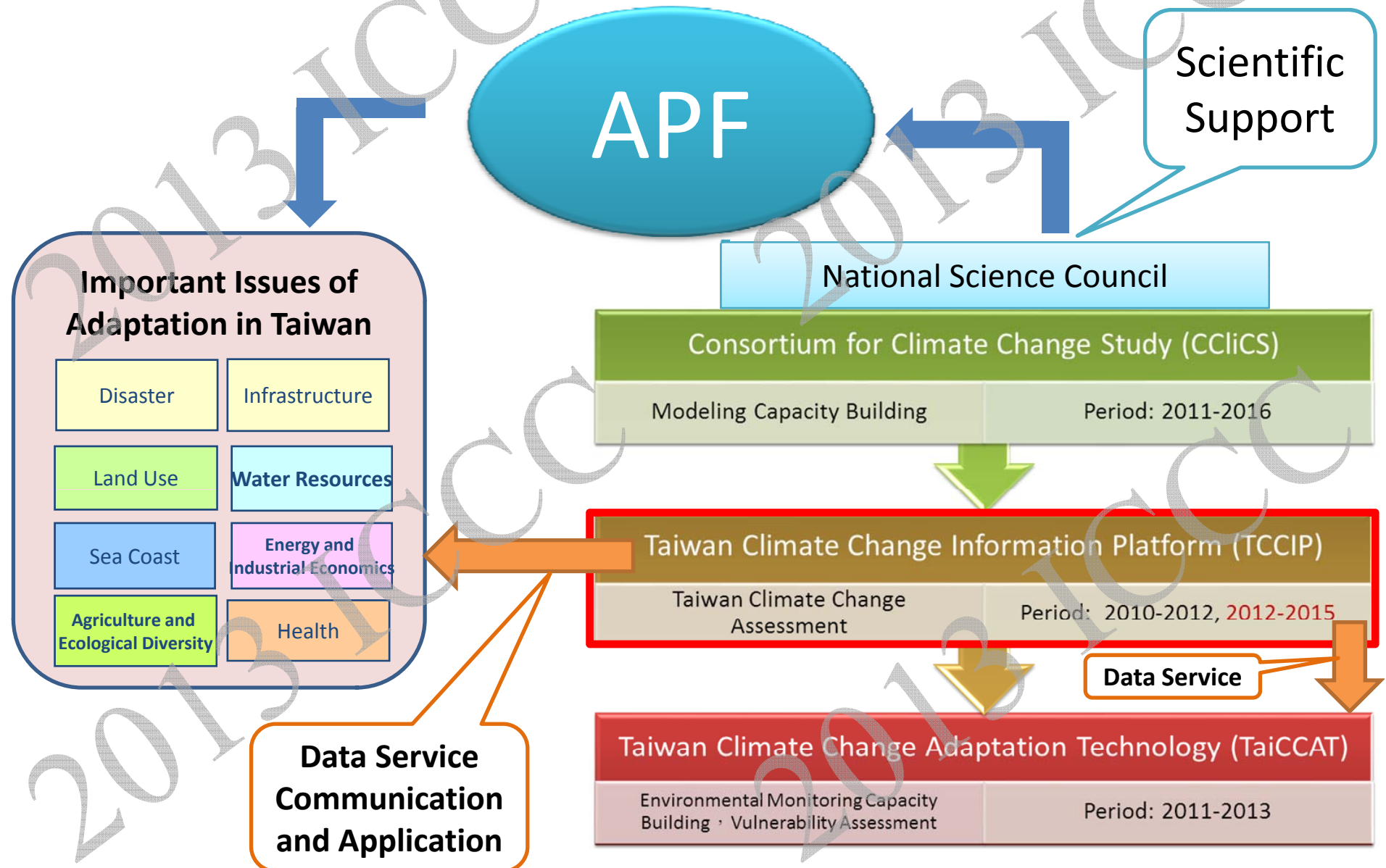


Taiwan Climate Change Adaptation Technology (TaiCCAT)

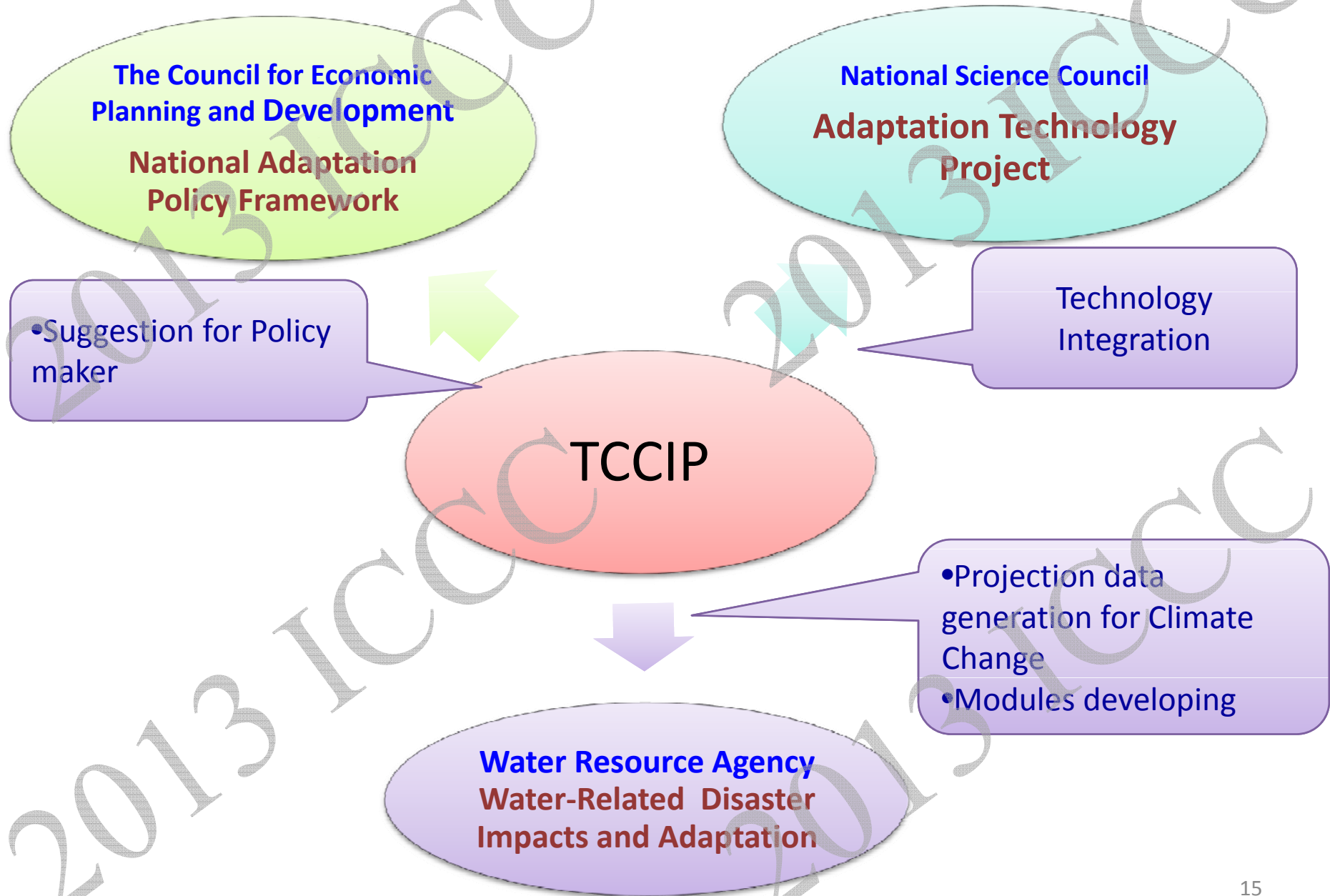
Environmental Monitoring Capacity
Building , Vulnerability Assessment

Period: 2011-2013

The Role of National Science Council in APF



The Role of TCCIP in Taiwan

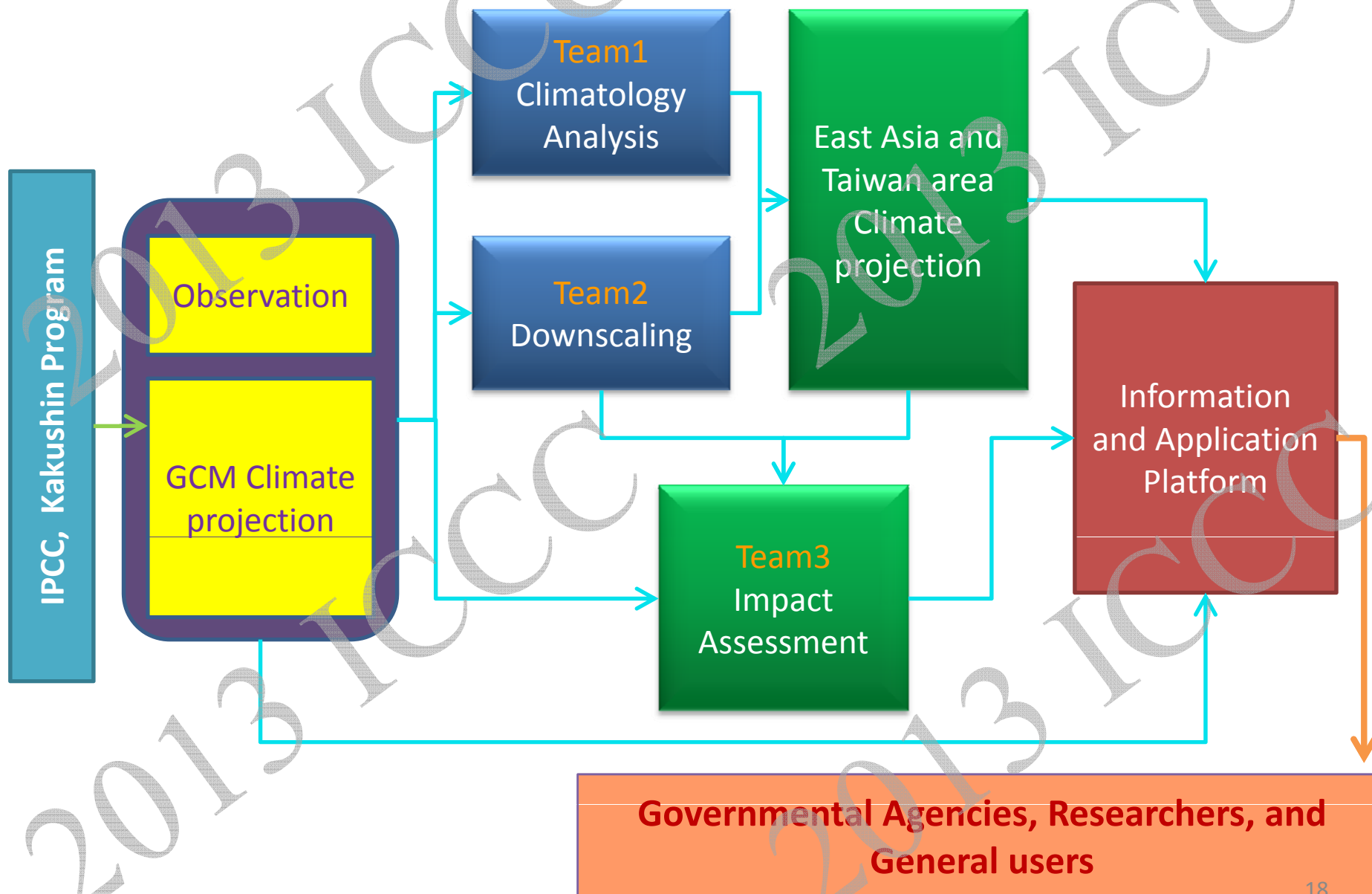


Why TCCIP ?

- **The impact of climate change** is a major concern to the government and the public. **Regarding the needs of science**, TCCIP was launched.
- The project promotes climate change research and integrates climate change impact applications. It aims to enhance climate change research in Taiwan, to consolidate the capacity for climate change research and projection, and to **implement** climate change information applications and services.

Achievement of TCCIP – an overview

Working groups of TCCIP



What we have done

For Climate
research

The first time to gather more than 1400 stations for long term rainfall record and to make it homogeneous and Gridded in Taiwan

High Resolution (5Km x 5Km) projection data based on Statistical downscaling in Taiwan

Projection data of extreme event based on Dynamic downscaling in Taiwan

Module creation for connection between Meteorology and Hydrology study on Climate Change

Observation

- Before TCCIP

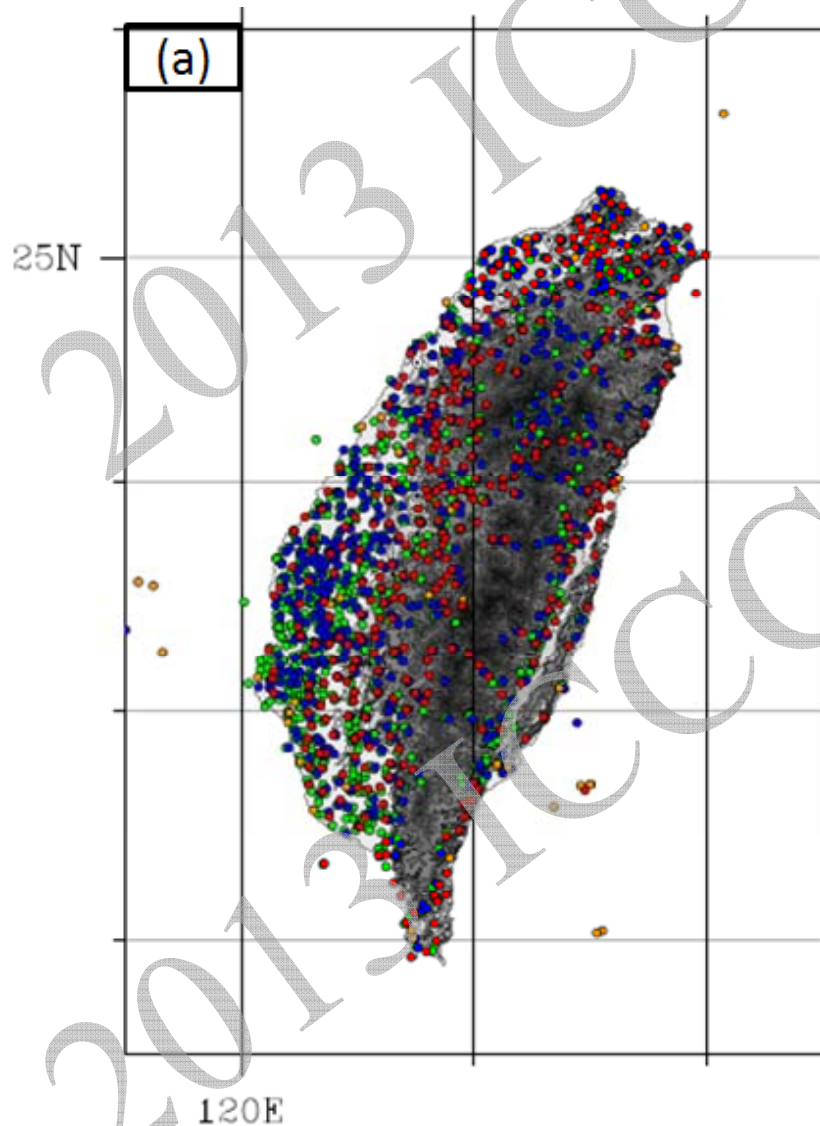
- Data scattered in different institutes
- Only Station data is available, no gridded data.

- After TCCIP

- Data from different institutes is integrated, and quality controlled.(more than 1400 stations)
- High-resolution(1Km X 1Km, 5 Km X 5Km) gridded data for more local impact application is derived.

Data scattered in different institutes

Sources/Distributions of Rainfall observations

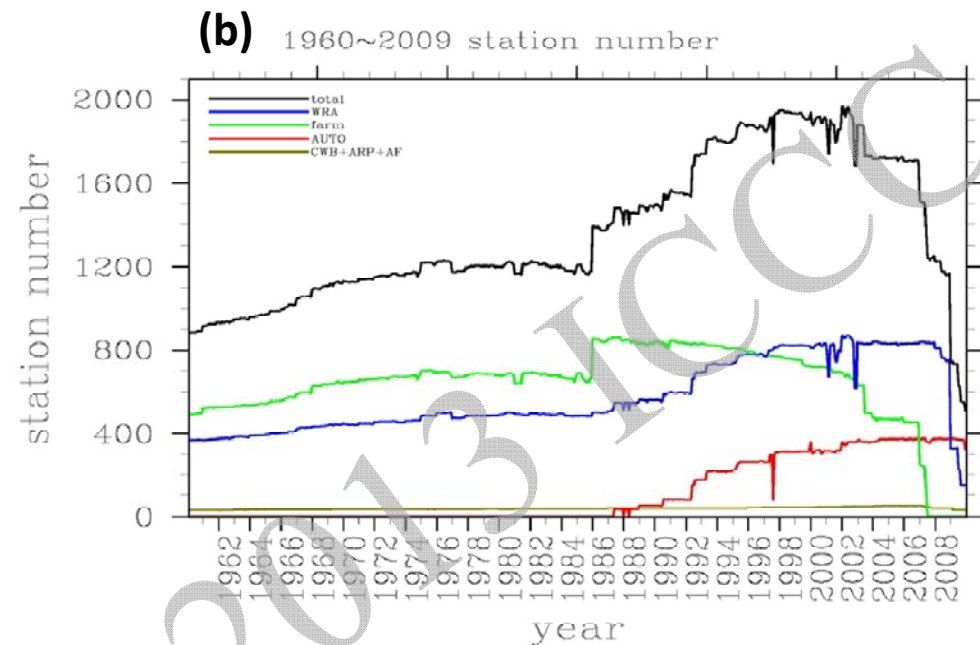


Red dots: CWB Auto-gauge

Green dots: Irrigation Associations

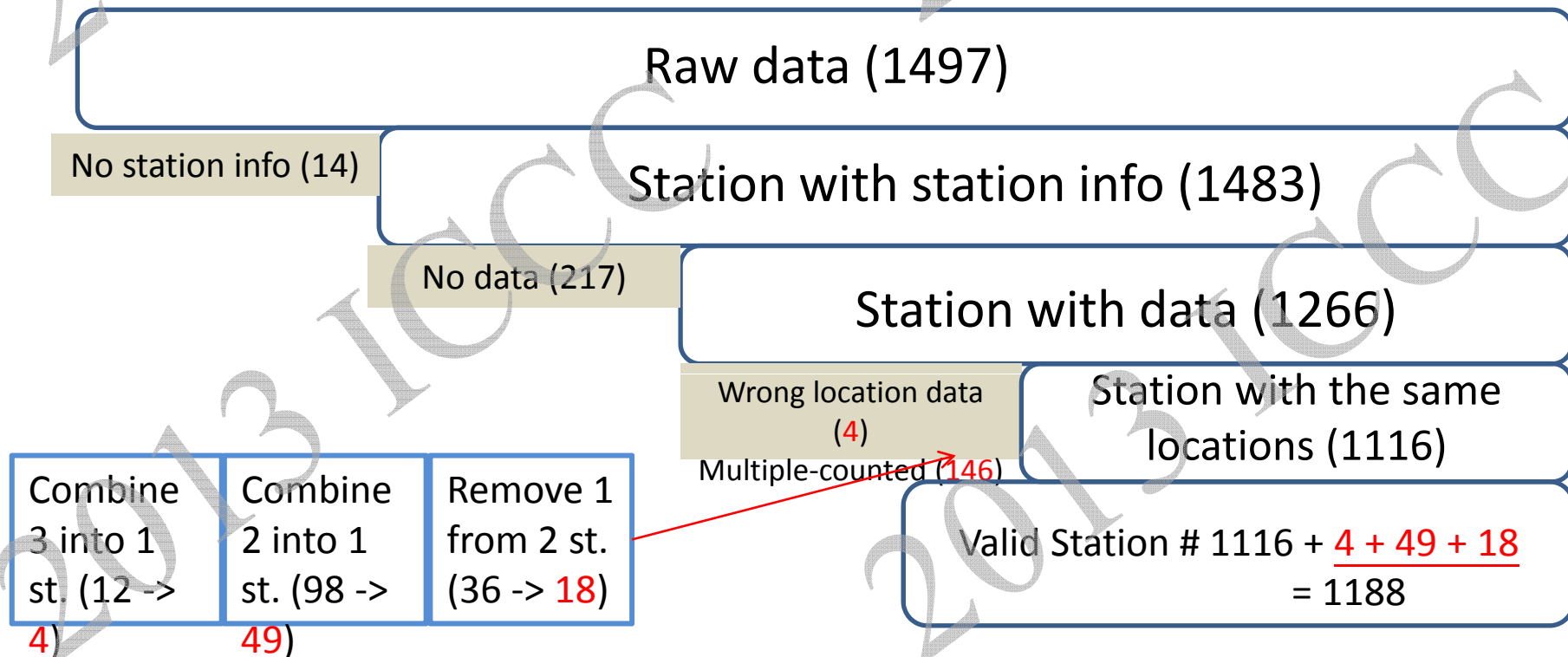
Golden dots: CWB+CAF+CAA

Blue dots: Water Resources Agency

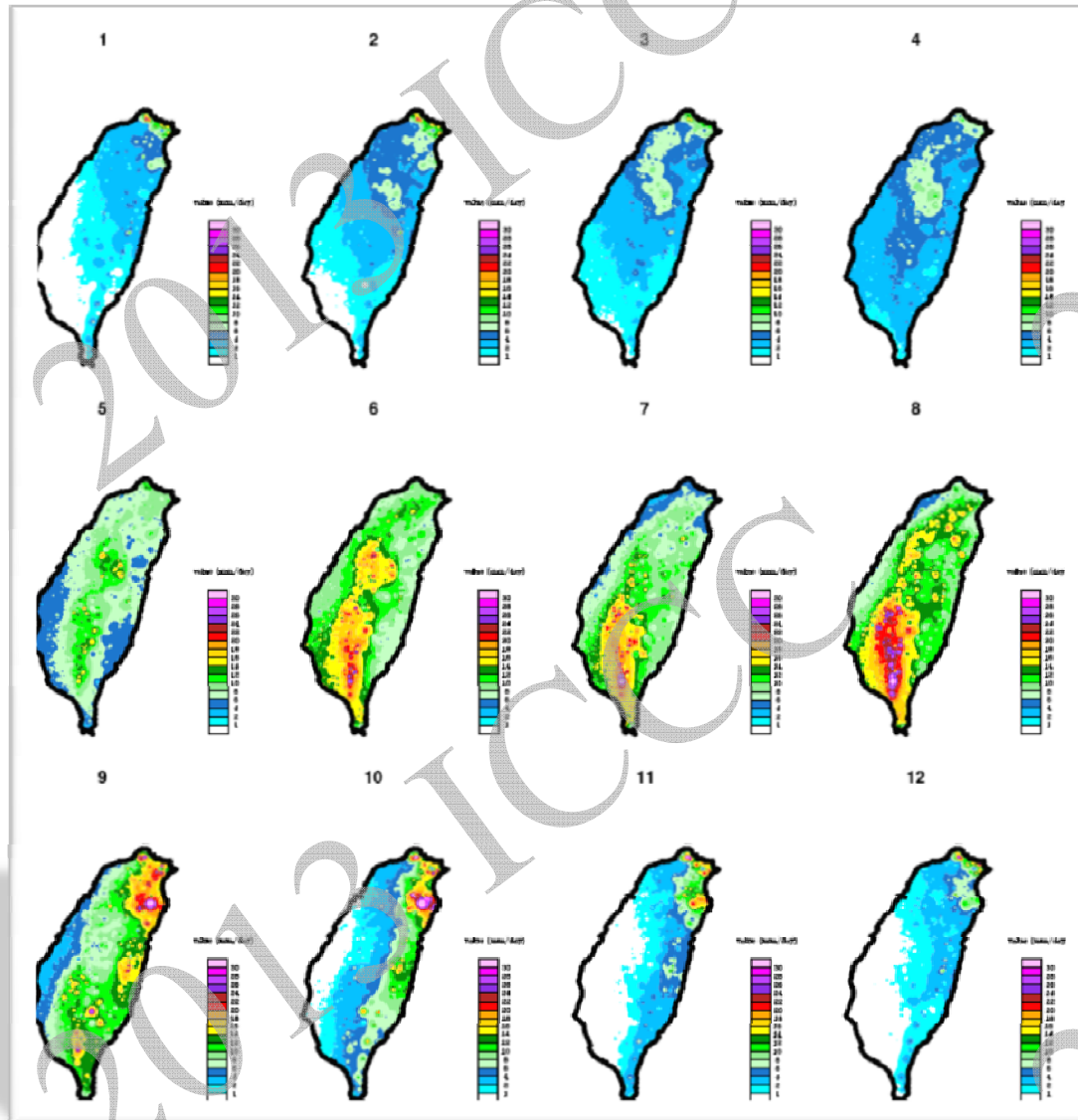


Data homogeneous process

- ✓ Remove stations without station info
- ✓ Remove stations without obs data
- ✓ Remove stations with wrong location data
- ✓ Combine/Remove multiple-counted stations



High-resolution gridded data is derived



High resolution Grid
format data archive

Datasets now available

(Jan 1960 – Dec 2009)

1km & 5km monthly mean Precip.

1km & 5km monthly mean Tavg

1km & 5km monthly mean Tmax

1km & 5km monthly mean Tmin

Datasets to be available

(Jan 1960 – Dec 2009)

1km & 5km Daily Precip.

1km & 5km Daily Tavg

1km & 5km Daily Tmax

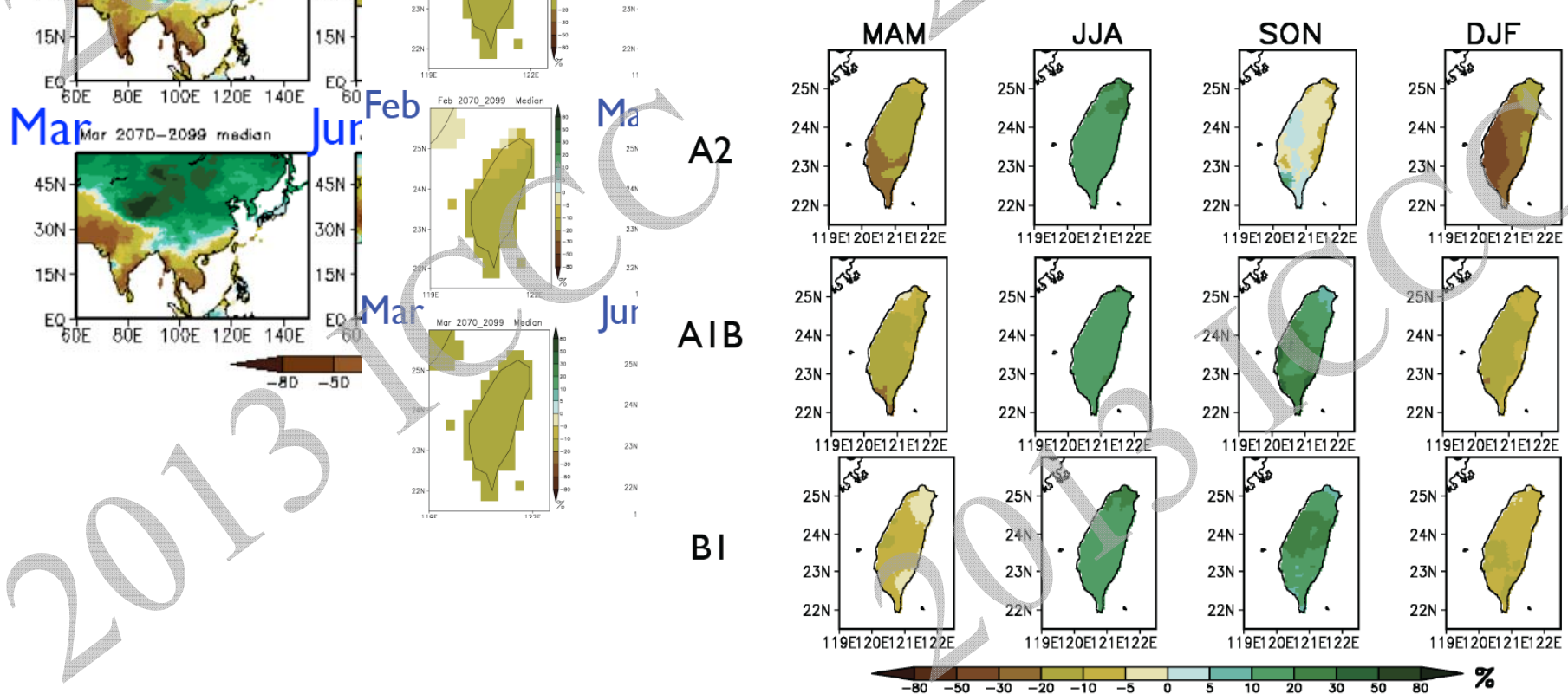
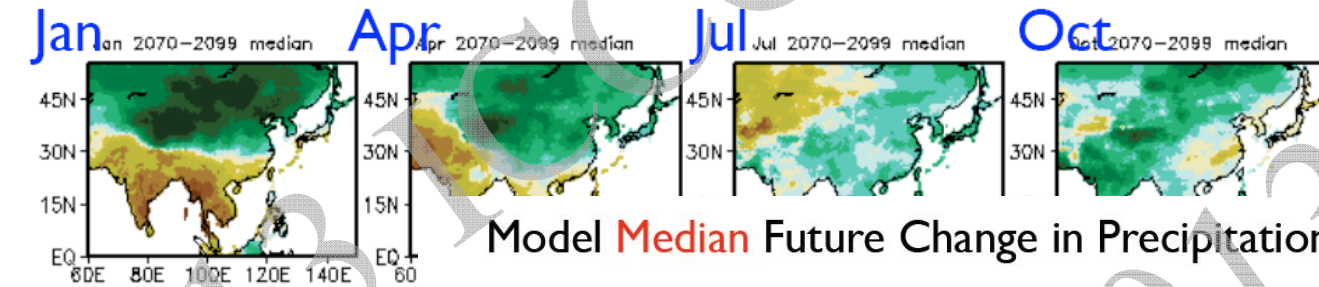
1km & 5km Daily Tmin

Climate Projection

- Before TCCIP
 - Only projected data on station scale can be obtained based on statistical downscaling.
 - Typhoon data in the future is unavailable .
- After TCCIP
 - Projected results can be downscaled to 25Km and 5Km in spatial coordination.
 - The impact of extreme events(typhoon) can be assessed by means of dynamic downscaling scheme.
 - More interaction between Meteorology and Hydrology.

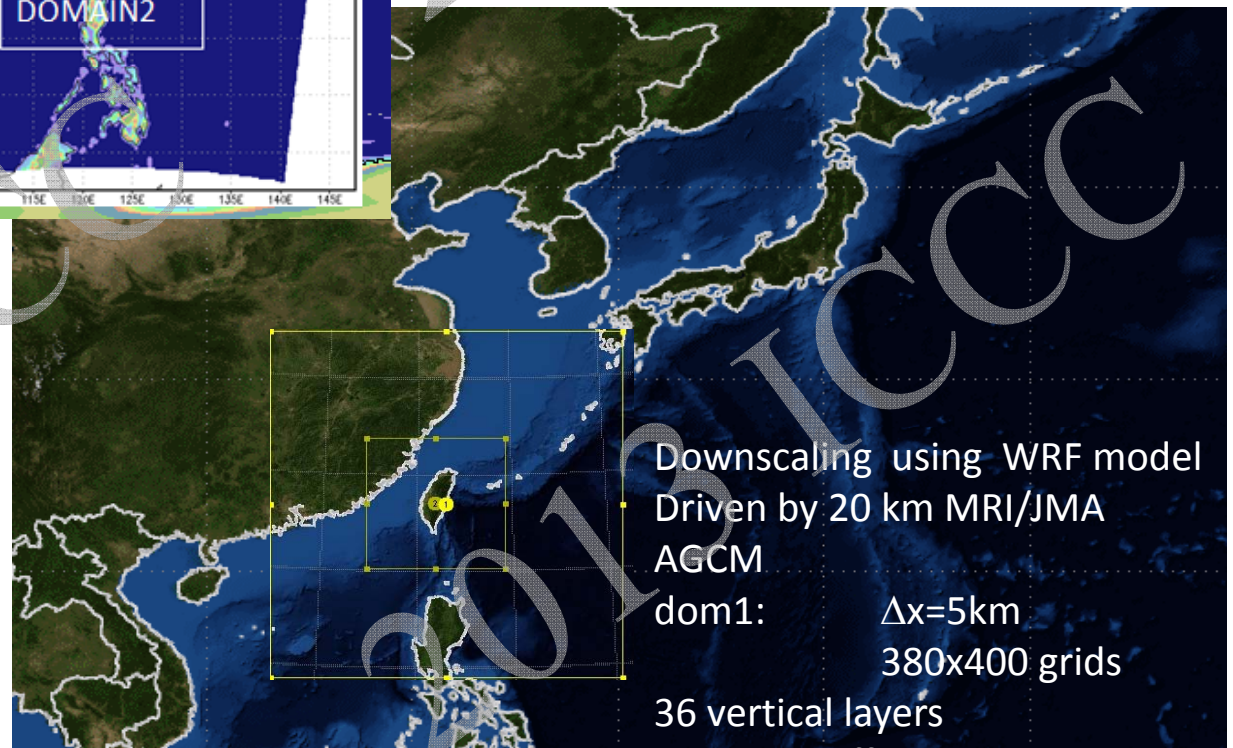
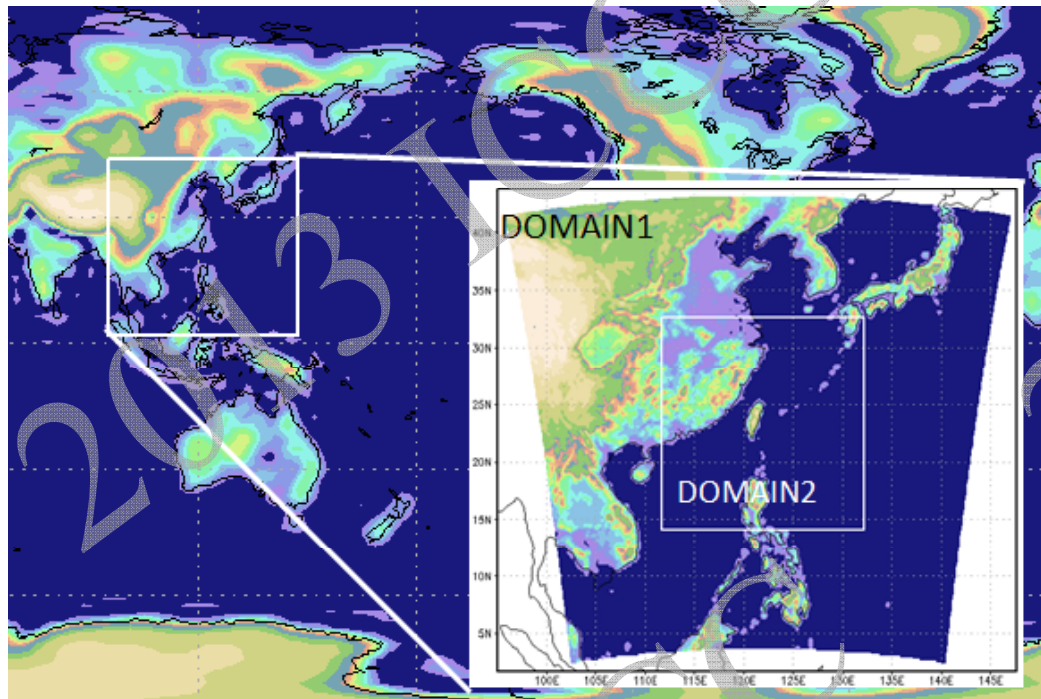
Model Median Future Change in Precipitation (%)

Statistical
Downscaling



Dynamical Downscaling

ECHAM5-WRF
& MRI-WRF



Application and Data service

- Before TCCIP
 - **Application** of climate projection is still **under construction**.
 - **Data** for climate change study **distributed in many places**.
- After TCCIP
 - **Science report 2011 tailoring for Taiwan** is published by NSC to give the **guidance for application** concerning climate change.
 - **Multiple tunnels for communication**—
 1. **Workshop on Data application and communication** is held by TCCIP for governmental agencies.
 2. **Information platform**
 - **Data** for climate change **can be provided systematically**.

Overview of TCCIP ----- Service and Communication

<http://satis.ncdr.nat.gov.tw/ccsr/>

Chapter 2
Global
Climate
Change
(Observation)

Chapter 3
EA/WNP
Climate
Change

Chapter 4
Natural
variability and
Interdecadal
change

Chapter 5
Regional
Climate
Change in
Taiwan

Chapter 6
Climate
Projection

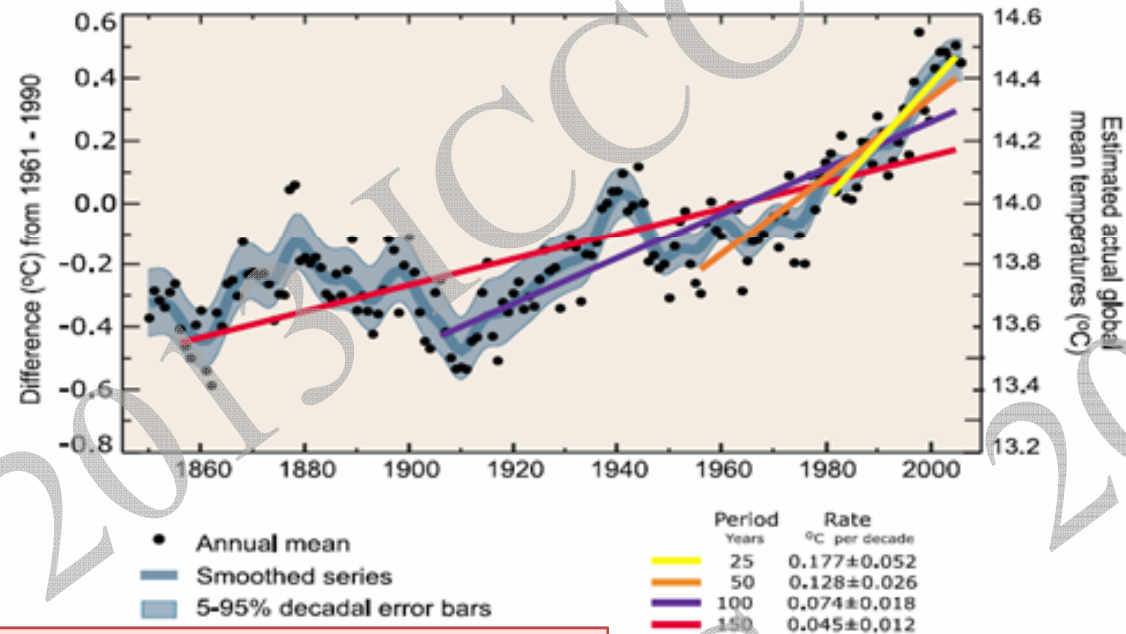
Chapter 7
Climate
Change and
Disaster
impact
analysis

TAIWAN CLIMATE CHANGE
SCIENCE REPORT 2011



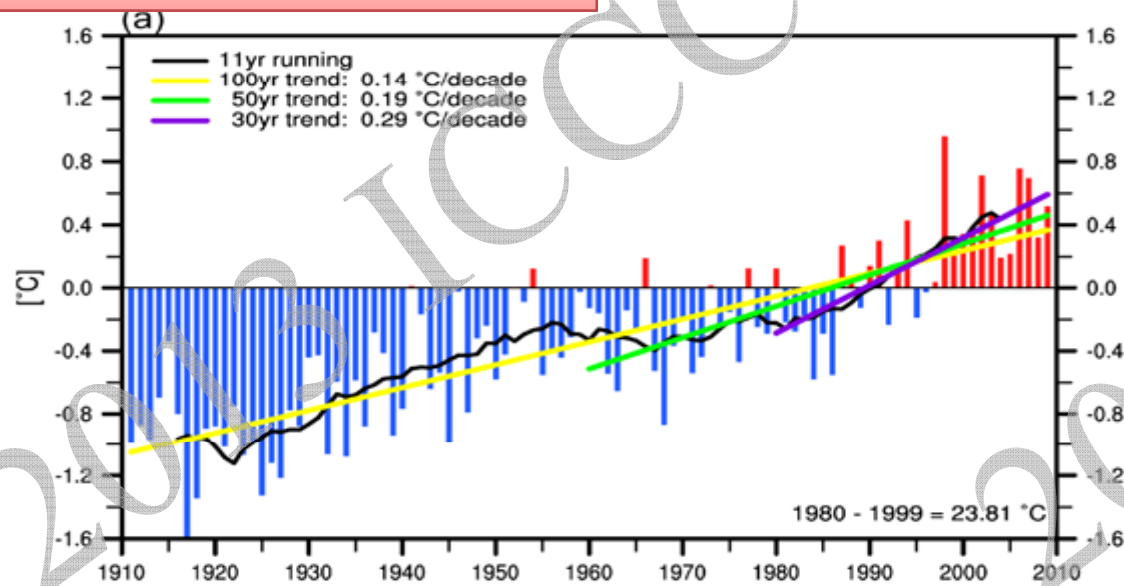
TAIWAN CLIMATE CHANGE SCIENCE REPORT 2011

Global surface temperature



Global surface temperature has increased by approximately 0.74°C in the past century (1906 to 2005)

Local surface temperature



Local surface temperature has increased by approximately 1.4°C in the past century (1906 to 2005)

Workshop of Data Service and Communication



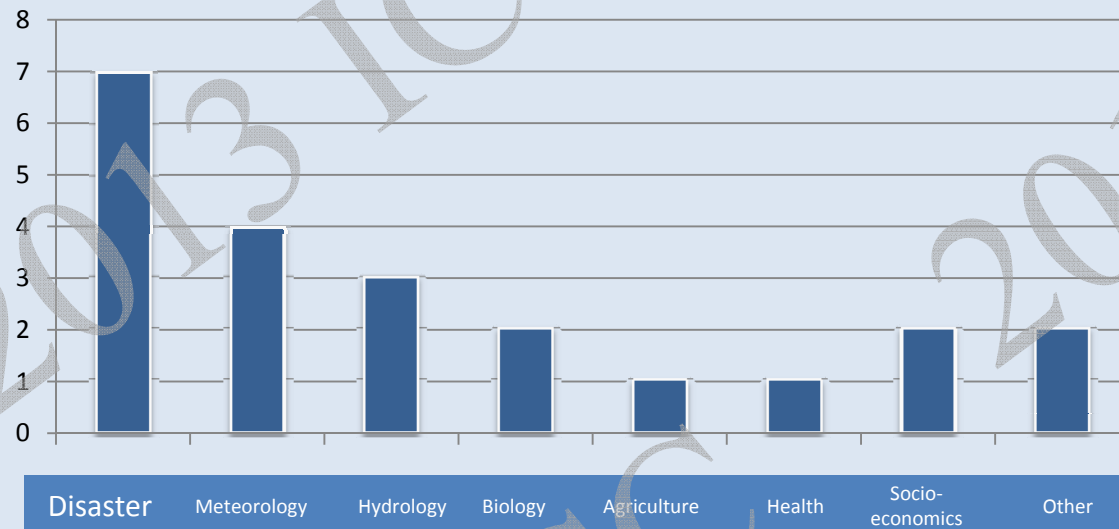
Workshop for Application of Science report 2011 and Projection data

1. Communicate with people from government agencies
2. More than 200 people to take part in
3. More discussion on application of projection data



Data Service and Communication

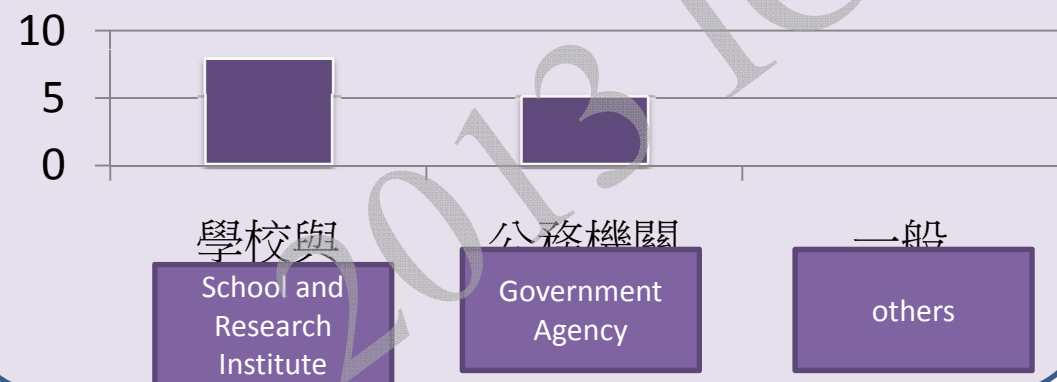
Data Service



People who apply projection data are mainly come from the field of Disaster prevention.

The government agencies and research institutes are the users that TCCIP plan to serve for the first stage.

Institutes



TCCIP Website



網站呈現方式 Sample



Main Content:

1. History of Taiwan climate
2. Future Projection of Taiwan rainfall and Temp.
3. Hydrological variability under Climate Change

Purposes:

1. Create a user-friendly platform
2. Design a flexible interface to display model projections
3. Share Climate Change products

Application of TCCIP—on water-related disasters

Rainfall Frequency Analysis (RFA)

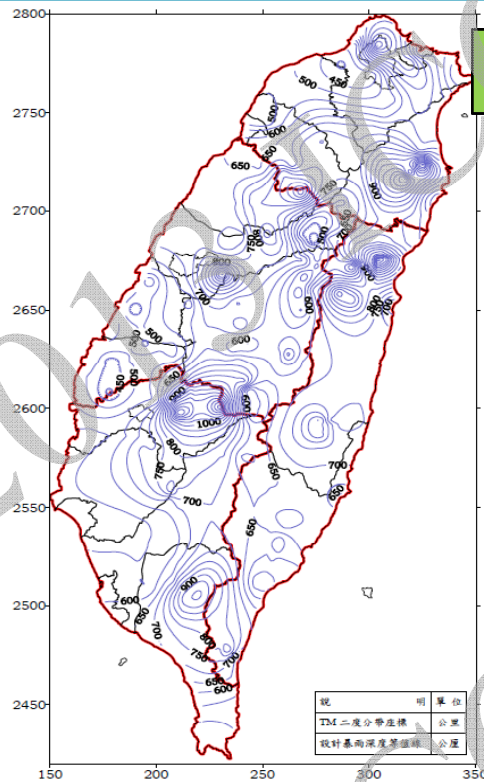
- Before TCCIP

- Conventional rainfall frequency analysis was implemented with **limited numbers(144 gauges)**, unevenly point-distributed raingauge and **various record lengths(>20 yr)**.
- Limited RFA results are not enough to describe spatial variation in mountainous area.

- After TCCIP

- **Grid data** was first calculated in Taiwan with **more gauges(1187 gauges)** and **longer record lengths(50 yr)**.
- **Upgradation of rainfall frequency analysis** with grid data

Upgradation of rainfall frequency analysis with grid data (more gauges and longer recording length)



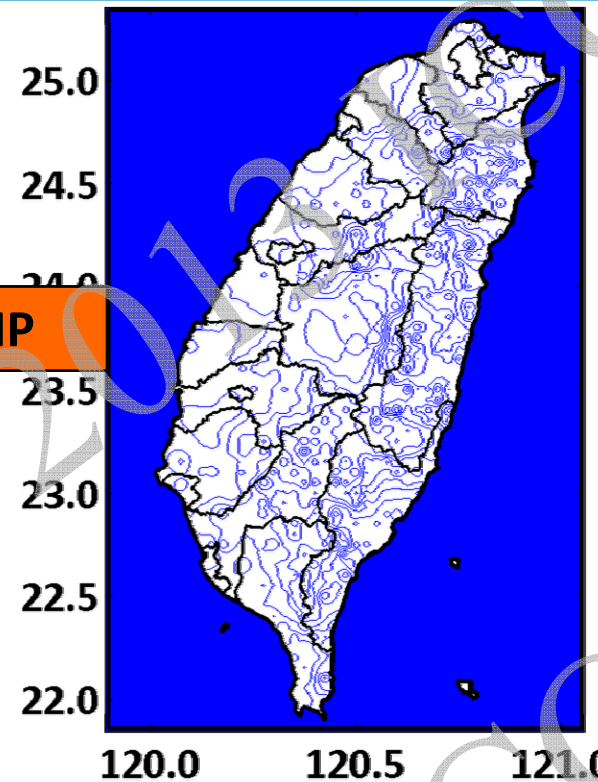
Before TCCIP

After TCCIP

Return period:
100 years
Design duration:
24hr

point type: gauges records

- 144 gauges, and recording length >20 years



raster type: grid data (5km)

- grid data set is produced with 1187 gauges of recording length 50 years
- With spatial resolution 5 kilometer, many spatial detail was demoed.

Rainfall frequency analysis in near future

- Before TCCIP

- Without dynamic downscaling projection data, trend analysis with observed data was conventionally extrapolated as future projection.

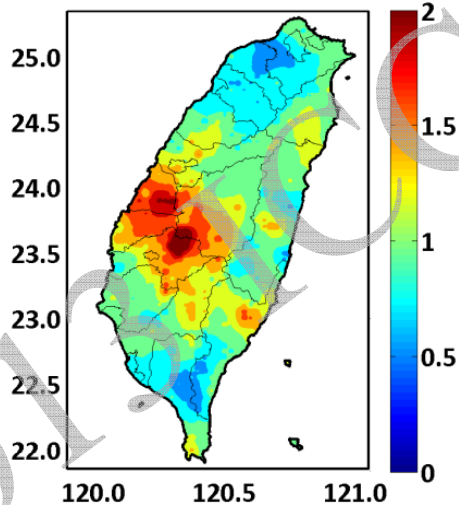
- After TCCIP

- With dynamic downscaling projection data, the change ratio of designed rainfall under climate change could be calculated.

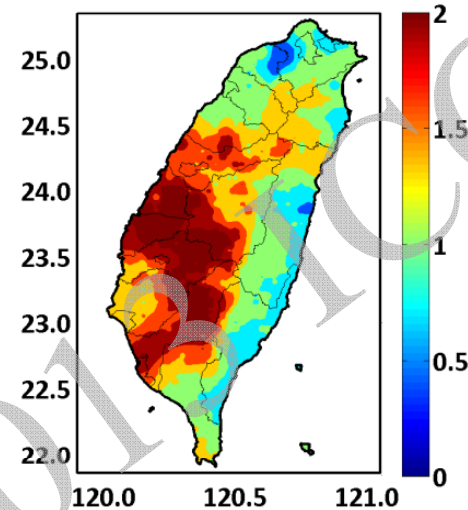
Change rate of future 100-year designed rainfall

- Assessing the change ratio of designed rainfall under climate change by using high-resolution hourly rainfall of dynamic downscaling data
- The first study of rainfall frequency analysis in Taiwan by using dynamic downscaling data

2015-2039/1979-2003



2015-2039/1979-2003



Return period: 100 year, rainfall duration:1 day, distribution type of annual maximum : PT3

The impact of future extreme typhoon event

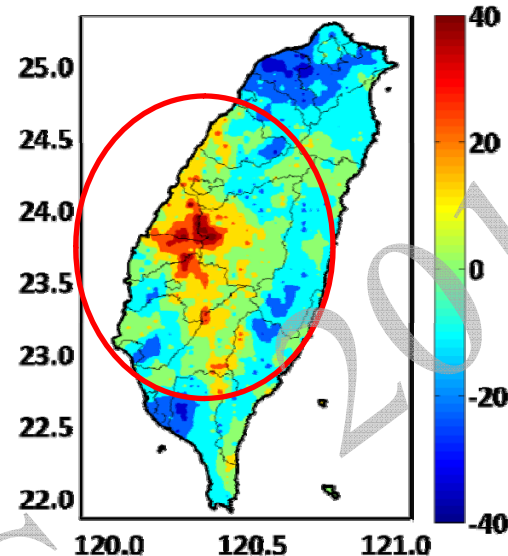
- Before TCCIP
 - Without dynamic downscaling projection data, the impact of future extreme typhoon event is difficultly assessed.
- After TCCIP
 - With MRI projection data, future typhoon event could be recognized.
 - With dynamic downscaling data, the characteristics of future extreme typhoon event were studied.

Change rate of future extreme typhoon event on total rainfall depth

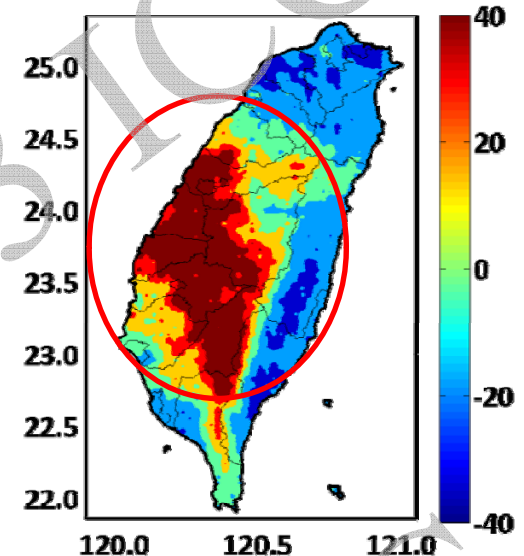
$$\text{Change Rate} = \left(\frac{\text{Future}}{\text{Base}} - 1 \right) \times 100$$

- Exploring the characteristic of typhoon by projection data
- Total rainfall during typhoon season significantly increased in the southern-west part of Taiwan.

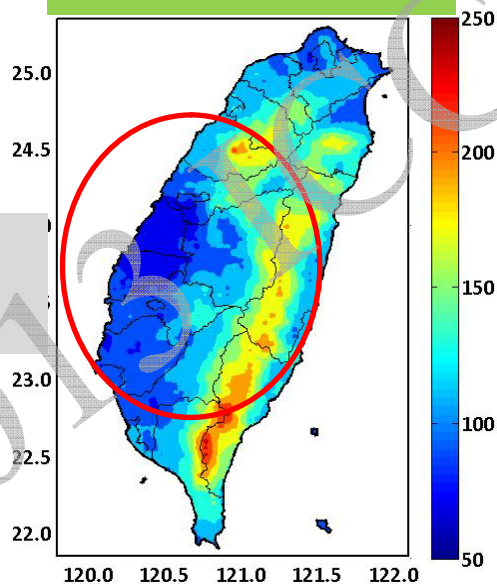
Average Total Depth (mm)-Typ-Near



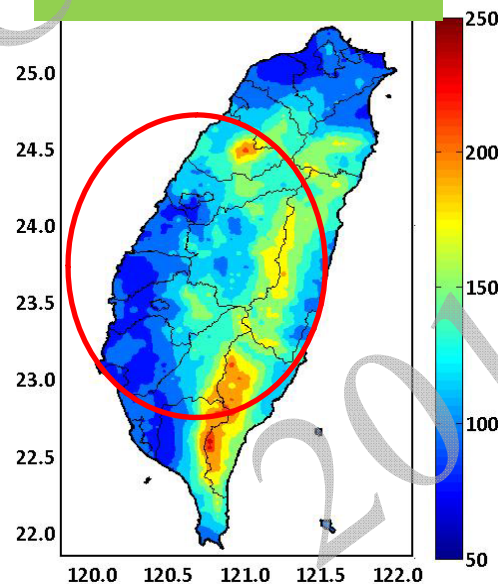
Average Total Depth (mm)-Typ-Far



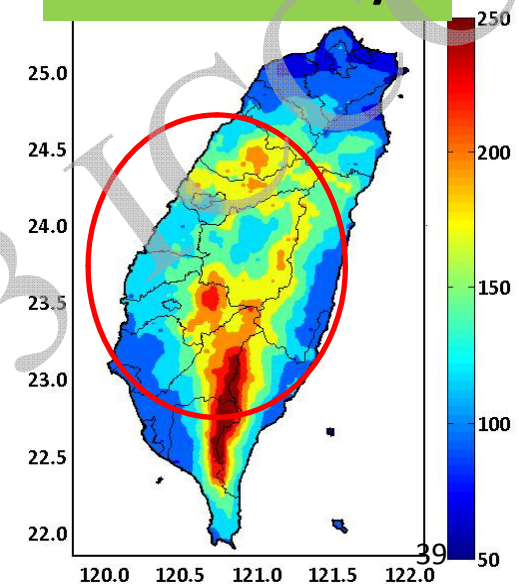
Base period



Near future



End of century

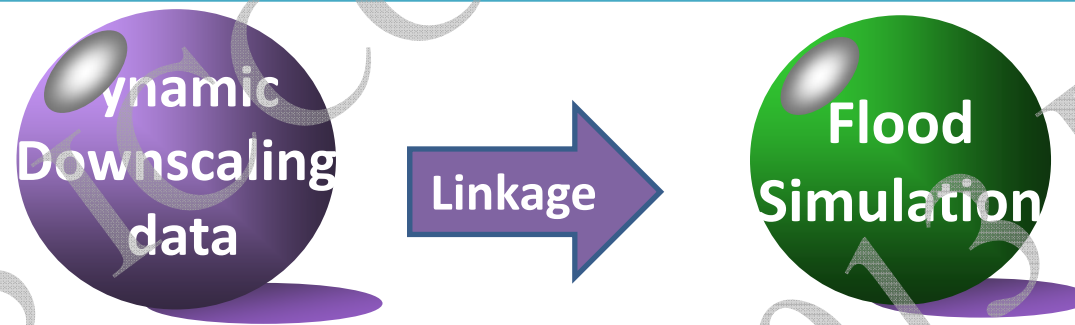


Projection data

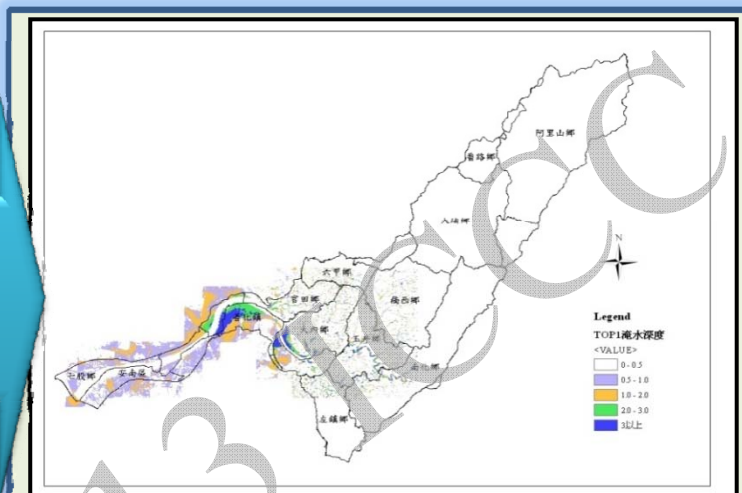
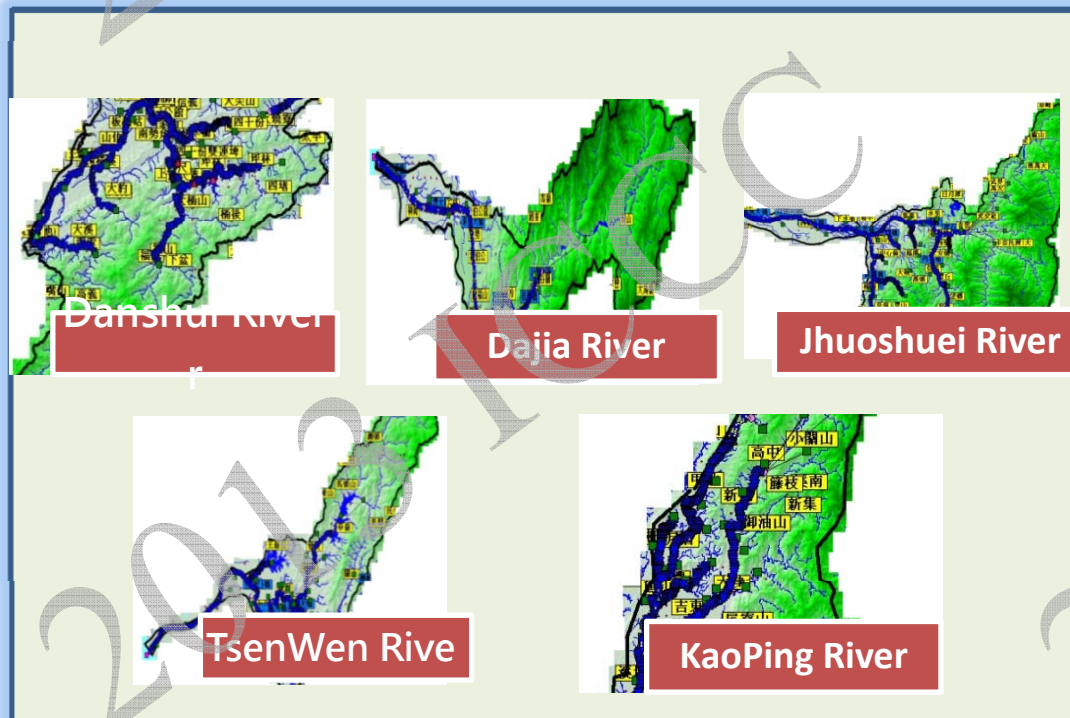
The flood impact of future extreme typhoon event

- Before TCCIP
 - Without dynamic downscaling projection data and well-developed modules, impact of future extreme typhoon event is difficult to be assessed.
- After TCCIP
 - An innovative module was created to connect RCM and flood simulation (SOBEK model) under climate change in Taiwan
 - With dynamic downscaling data, the flood characteristics of future extreme typhoon event were studied.

Modules creation for connection between meteorology and flood simulation



Creating an innovative module to connect RCM and flood simulation (SOBEK model) under climate change in Taiwan

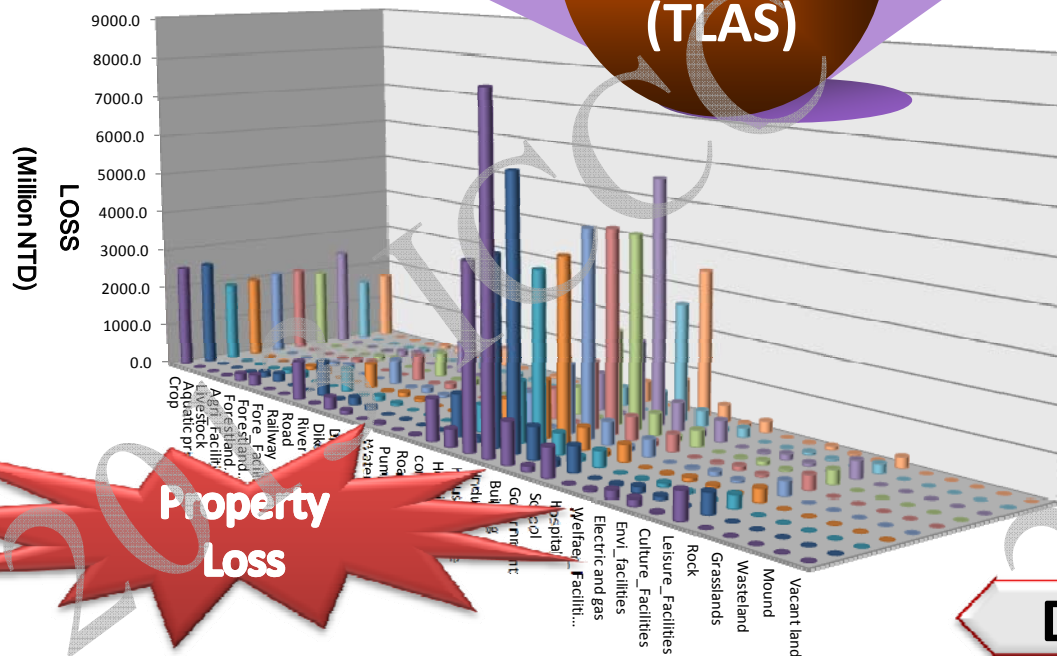
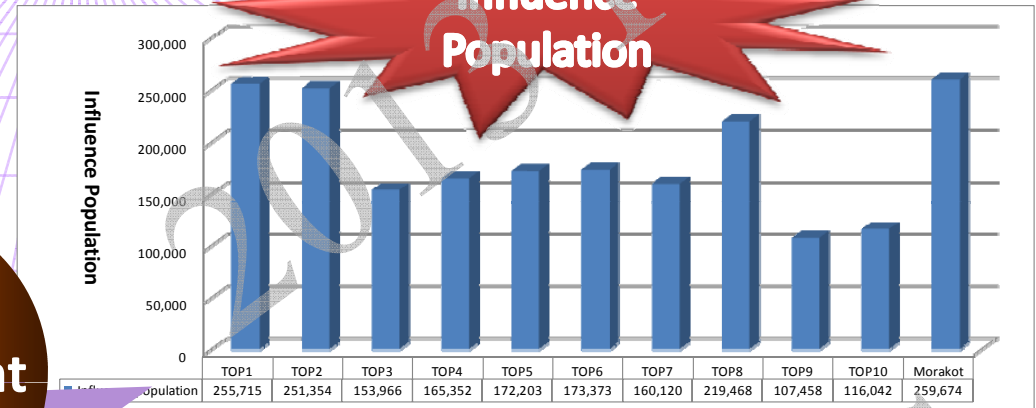
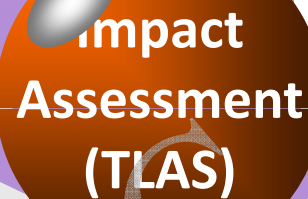


A simulation analysis of the impact of climate change on flooding in the Tsen-Wen catchment

The loss assessment of future extreme typhoon event

- Before TCCIP
 - Without dynamic downscaling projection data and well-done modules, the assessment of future flood loss is quite tough.
- After TCCIP
 - Taiwan typhoon Loss Assessment System (TLAS)
 - An innovative module was created to connect meteorology, flood simulation and TLAS under climate change in Taiwan.
 - With dynamic downscaling data, the flood loss of future extreme typhoon event were examined.

Modules creation for connection among meteorology, flood simulation, and TLAS



To build an innovative process for assessment of property loss:

**GCM=> RCM => Stream
Flow Model => TLAS**

Different Land Usage

Impact studies of hydrological stream flow

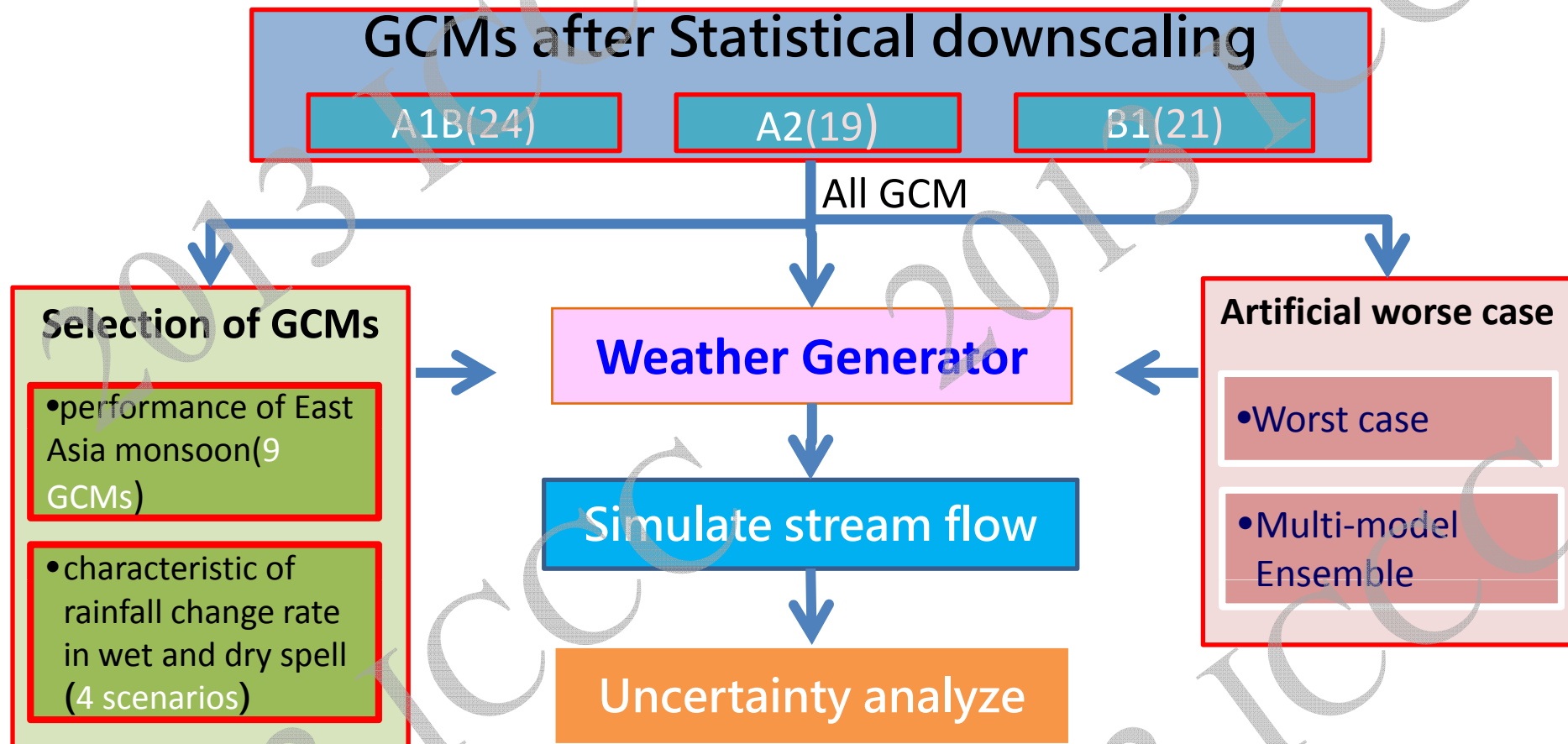
- Before TCCIP

- IPCC GCM data is not fully used in hydrological application in Taiwan.
- There is rare mutual-understanding on the definitions of base line, future period, scenarios, ...etc.
- Stream flow's projection is mainly based on grid data with coarse-resolution from GCM.

- After TCCIP

- Statistically downscaling data of 24 GCM
- More mutual-understanding on climate-change studies through inter-disciplinary communication
- An innovative module was created to connect GCM selection, meteorology, and hydrology under climate change in Taiwan.

Modules creation for connection between meteorology and hydrological stream flow



1. Even spread of impact results from all GCMs are not good for adaptive policy making and strategies acting
2. Artificial worst-case scenario was suggested for no-regret policy making
3. Regional climatic characteristics was also considered on scientific viewpoint

Selection of GCMs for impact studies of water resources

- Before TCCIP

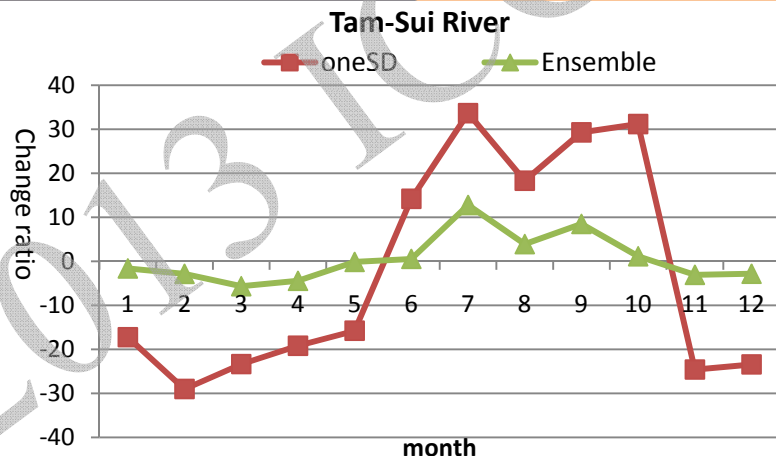
- Selection of GCM is based on performance of base-line period with observations.
- Lack of inter-disciplinary viewpoints

- After TCCIP

- GCM's performance of East Asia monsoon, and characteristics of rainfall change rate in wet and dry spell, are suggested for impact studies of water resources.
- Considering safe factor, an artificial worst case was designed by 1. ensemble mean, 2. plus and 3. minus one standard deviation based on 24 GCMs.

Selection of GCMs for impact studies of water resources

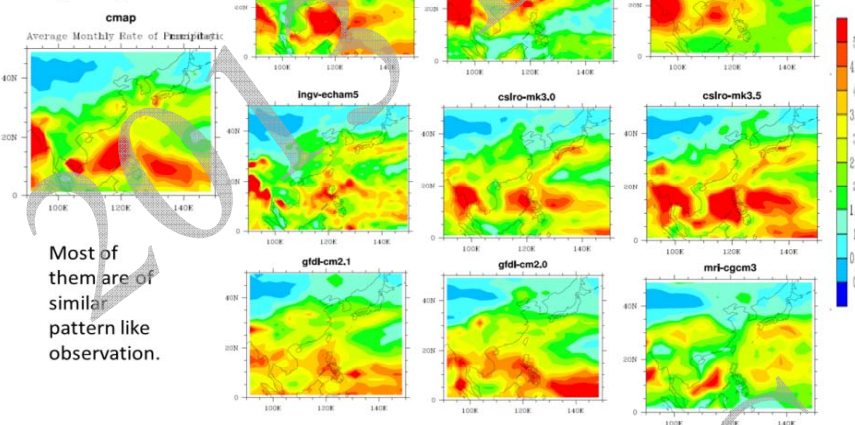
① Artificial worse case



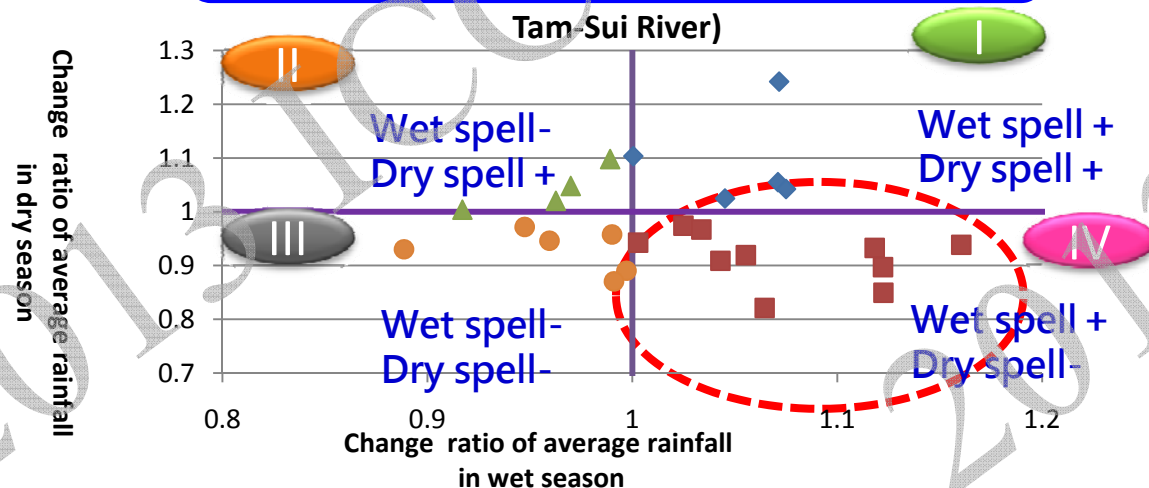
Multi-model ensemble + one time standard deviation

② GCMs' performance of East Asia monsoon

Precipitation Variability during Mei-yu season



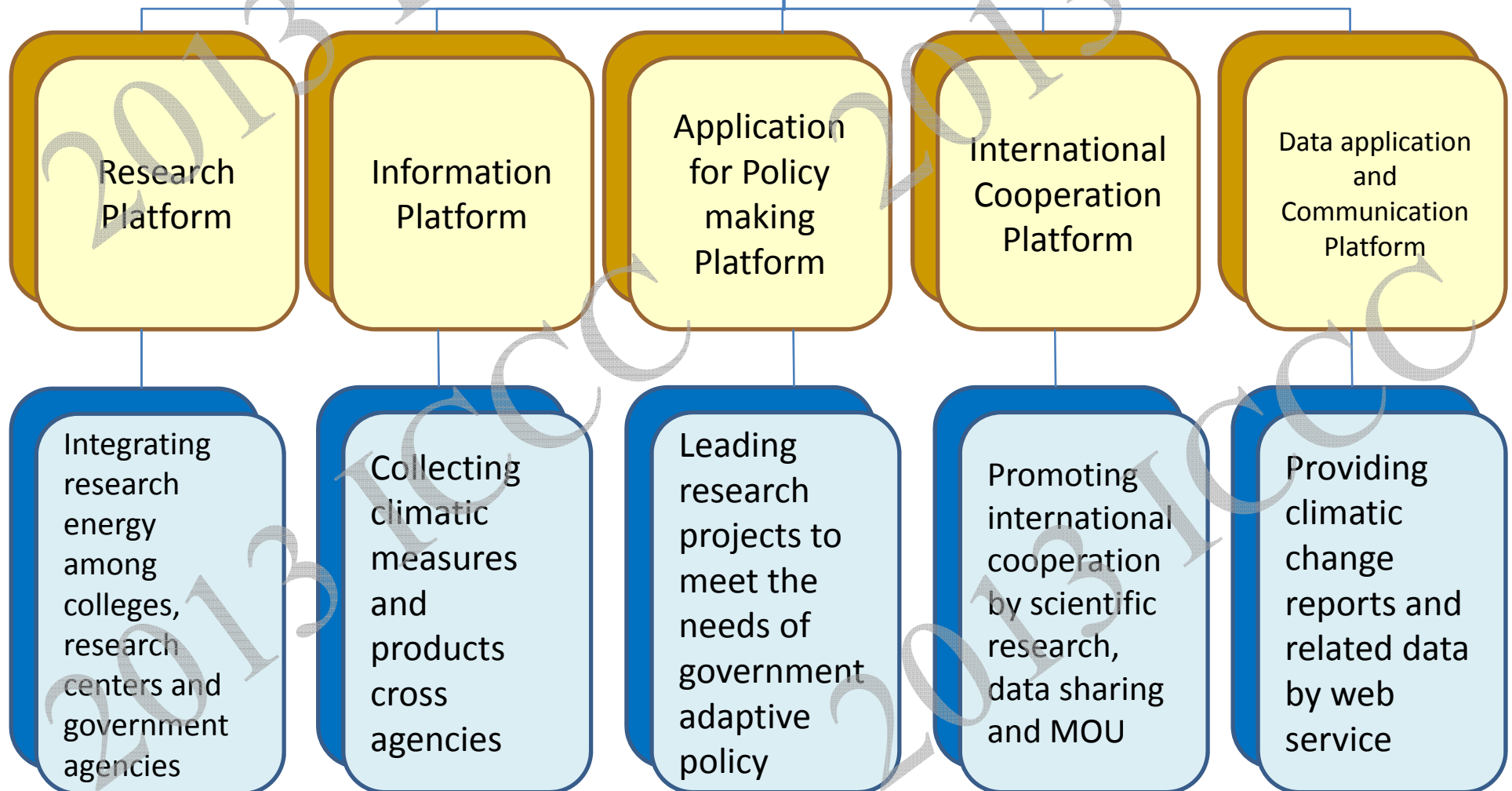
③ Based on characteristic of rainfall change rate in wet and dry spell



Different Strategies are made for Application of Water resource using Projection data of Statistical Downscaling concerning Climate Change

Summary

Platform for Climate Change Research and Application



Thanks for your attention!