CLIMATE CHANGE ADAPTATION

Presented by Irene Nielson, Climate Change Coordinator

for the

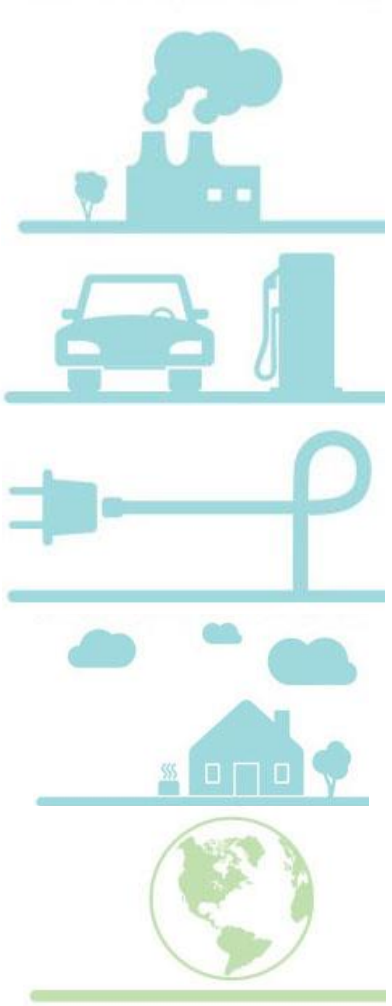
2014 Pan Pacific International Conference on Climate Change Adaptation

Taipei, Taiwan

29 September-1 October

EPA Mitigation Actions Under President Obama's Plan

- Reducing carbon pollution from power plants
- Building a 21st century transportation sector
- Cutting energy waste in homes, businesses, and factories
- Reducing methane and HFCs
- Leading international efforts to address global climate change

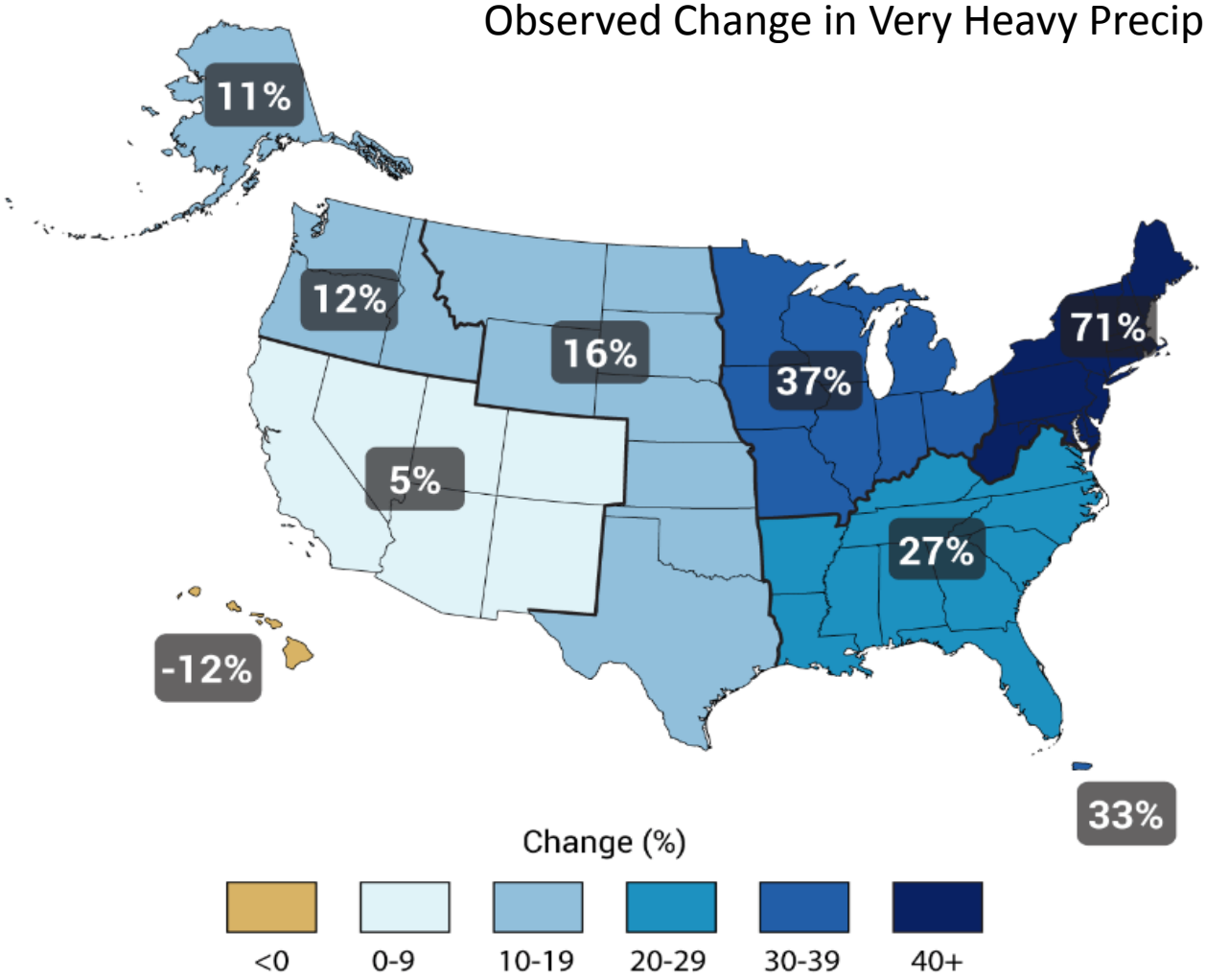


National Climate Adaptation Initiatives

- Federal Agency Adaptation and Implementation Plans
- Executive Order "Preparing the U.S. for the Impacts of Climate Change"

National Climate Assessment

Observed Change in Very Heavy Precipitation



The map shows percent increases in the amount of precipitation falling in very heavy events (defined as the heaviest 1% of all daily events) from 1958 to 2012 for each region of the continental United States. Karl 2009.

1958-2012

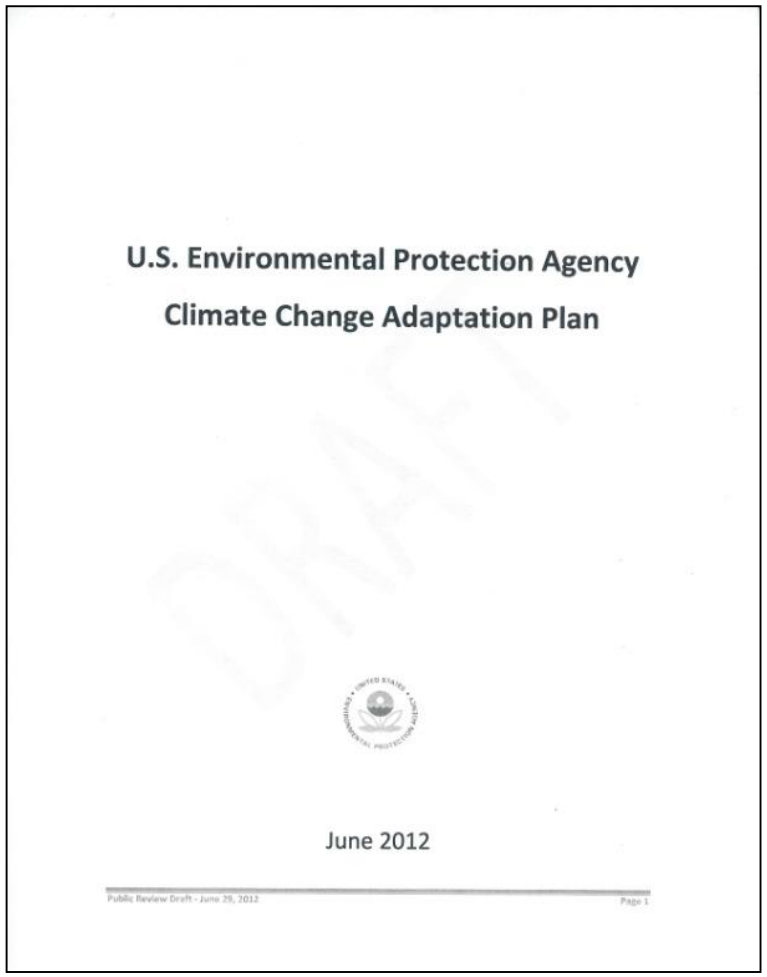
USA: Combined Sewer Overflows

1.2 trillion gal of sewage & stormwater a year discharged during combined sewer overflows – would keep Niagara Falls roaring for 18 days

Examples of the Importance of Climate Adaptation for EPA's Mission

- **Water:**
  - ✓ Increased risk of sewer overflows and wastewater bypasses
  - ✓ Integrity of coastal water infrastructure systems could be put at increased risk
  - ✓ Saltwater intrusion in surface water and ground water, placing increased demands on drinking water treatment
  - ✓ Increased pollutant loads to water bodies could increase annual treatment costs
- **Air:**
  - ✓ Increased tropospheric ozone pollution in certain regions could make it more difficult to attain standards for ozone in many areas with existing ozone problems
- **Clean-up of Contaminated Sites and Waste Management:**
  - ✓ Increased risk of contaminate release from EPA sites due to increasing heavy precipitation events, increasing risk of floods, and sea level rise
- **EPA Facilities and Operations:**
  - ✓ Increased risks to EPA facilities in coastal or flood-prone areas

EPA Climate Change Adaptation Plan


U.S. Environmental Protection Agency

Climate Change Adaptation Plan

DRAFT

June 2012

Public Review Draft – June 29, 2012 Page 1

- Part 1: Vision of the Future EPA
- Part 2: Identifies known Vulnerabilities to EPA's Mission from Climate Change
- Part 3: Mainstreaming Climate Change Adaptation in EPA: Agency-wide priorities
- Part 4: Measuring and Evaluating Performance

http://epa.gov/climatechange/pdfs/EPA-climate-change-adaptation-plan-final-for-public-comment-2-7-13.pdf

Implementation Plans

Climate Change Home
Basic Information
Greenhouse Gas Emissions
Science
Impacts & Adaptation
Alaska
U.S. Islands
Southwest
Southeast
Northeast
Northwest
Midwest
Great Plains
International
Human Health
Ecosystems
Forests
Transportation
Energy
Coasts
Agriculture and Food
Society
Water Resources
Adaptation Overview
Tools for Public Officials
Federal and EPA Programs
What EPA is Doing
What You Can Do
Newsroom
Glossary
Students' Site

EPA Adaptation Implementation Plans

In early November, 2013 EPA released 17 Program and F
comment period. The public is invited to review and pro
public docket at www.regulations.gov (Docket Number
Federal Register Notice is published. If you are providin
identify which of the 17 Plans your comments refer to.

These draft *Implementation Plans* were prepared by EPA
publication of the Draft Climate Change Adaptation Pla
ongoing effort to address adaptation across the federal
Leadership in Environmental, Energy, and Economic Per

- Memo from the Acting Associate Administrator for

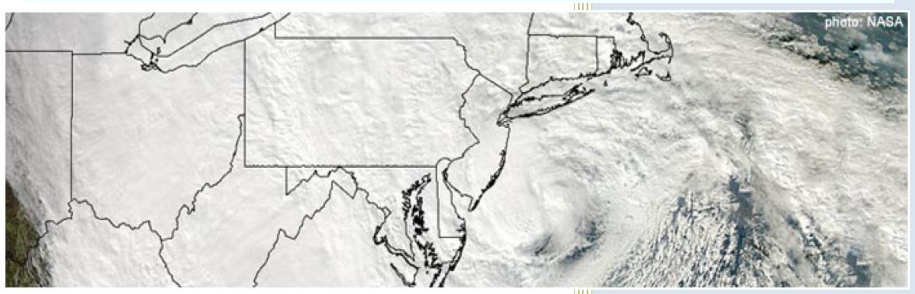
Program Implementation Plans

- Office of Water (PDF, 46pp, 951kb)
- Office of Air and Radiation (PDF, 19pp, 282kb)
- Office of Solid Waste and Emergency Response (PDF
- Office of Chemical Safety and Pollution Prevention (
- Office of International and Tribal Affairs (PDF, 13pp,
- Office of Research and Development (PDF, 18pp, 383k
- Office of Administration and Resource Management

Regional Office Implementation Plans

- Region 1 (PDF, 67pp, 1,440kb)
  - Addendum (PDF, 2pp, 72kb) to Region 1 Implementa
- Region 2 (PDF, 41pp, 848kb)
- Region 3 (PDF, 28pp, 474kb)
- Region 4 (PDF, 139pp, 2,298kb)
- Region 5 (PDF, 54pp, 609kb)
- Region 6 (PDF, 39pp, 561kb)
- Region 7 (PDF, 52pp, 720kb)
- Region 8 (PDF, 32pp, 1,014kb)
- Region 9 (PDF, 46pp, 640kb)
- Region 10 (PDF, 92pp, 1,170kb)

EPA Region 2 Climate Adaptation Plan



Examples of Priority Commitments

State Revolving Loan Funds: EPA's National Water Program will recognize and encourage climate change consideration in the management of Clean Water and Drinking Water State Revolving Loan Funds.

Brownfield Grants: The EPA Office of Solid Waste and Emergency Response will require brownfield grant recipients to take potential changing climate conditions into consideration when evaluating cleanup alternatives.

Climate Ready Water Utilities Program: Work with water suppliers to assess risks from climate change and explore how to prepare.

EPA Region 2: Work with stakeholders to build climate resiliency into Hurricane Sandy recovery activities.

EPA Region 5: Will integrate consideration of climate impacts and adaptation into Great Lakes Restoration Initiative-funded projects.

EPA Region 8: Work with regulated federal facilities to ensure they are designed to manage stormwater to help limit pollution loads in local water bodies.

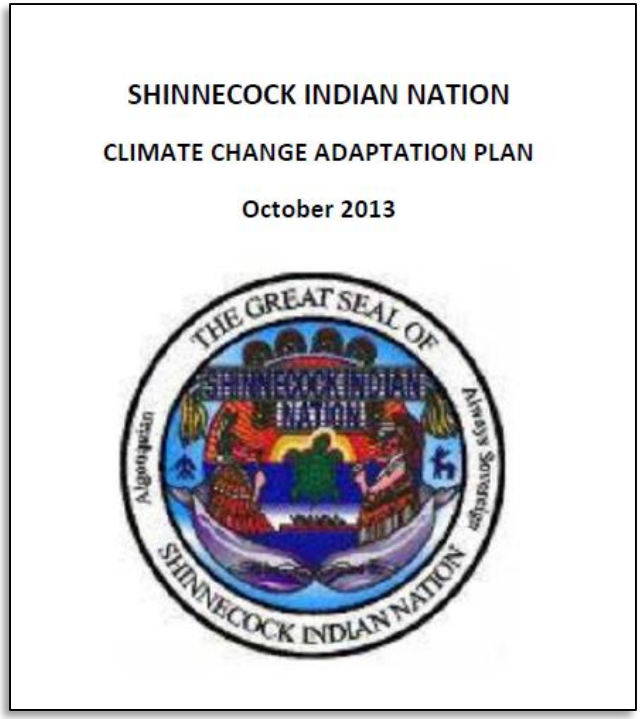
Central Element of EPA's Efforts: Building Adaptive Capacity

EPA will mainstream climate adaptation planning by:

- Building and strengthening the "adaptive capacity" of its staff and its partners in the states, tribes, and local communities
- Supporting their efforts to integrate climate adaptation into the work they do by:
  - ✓ increasing awareness of ways climate change may affect their ability to implement effective programs
  - ✓ providing necessary data, information and tools

Empower communities through partnerships

Tribal Nations Adaptation Plans



- Shinnecock Indian Nation Climate Adaptation Plan

  ACTION RECOMMENDATIONS:

  - Shoreline stabilization with native plants and shrubs
  - Research on water quality for shellfish cultivation
  - Increase resilience to flooding and sea level rise
  - Emergency management plans for extreme weather
  - Groundwater contamination improvements through community sewers
  - Carbon footprint reduction through energy audits of tribal buildings and renewable energy programs
  - Food security through community farming and traditional food systems
  - Air quality improvements through ordinances on open burning, idling and tree loss

Climate Adaptation

U.S. EPA TOOLS

Climate Ready Water Utilities

Climate Resilience Evaluation & Awareness Tool
Risk assessment tool designed to build climate change knowledge and support adaptation planning in the water sector.

CRWU Toolbox
Toolbox is searchable resource containing information to support the "Climate Ready" process, including government and utility activities, workshops, publications, funding, and tools.

Tabletop Exercise Tool for Water Systems
Customizable materials for designing exercises for utilities to consider long-term planning measures in order to mitigate the potential impacts of climate change.

CLIMATE READY WATER UTILITIES EPA

CRWU Website:
http://water.epa.gov/infrastructure/watersecurity/climate/

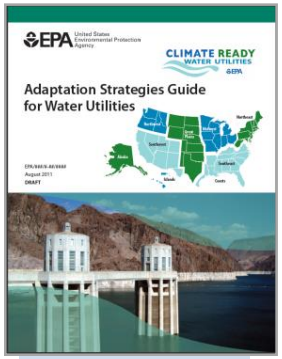
Climate Ready Water Utilities

Climate Ready Process

Adaptive Response Framework

Explore Elements of Climate Readiness

Adaptation Strategies Guide



Learn Climate and Adaptation Basics

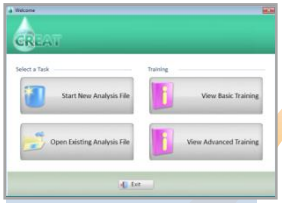
Toolbox

Research and Gather Information

Extreme Events Workshop Planner

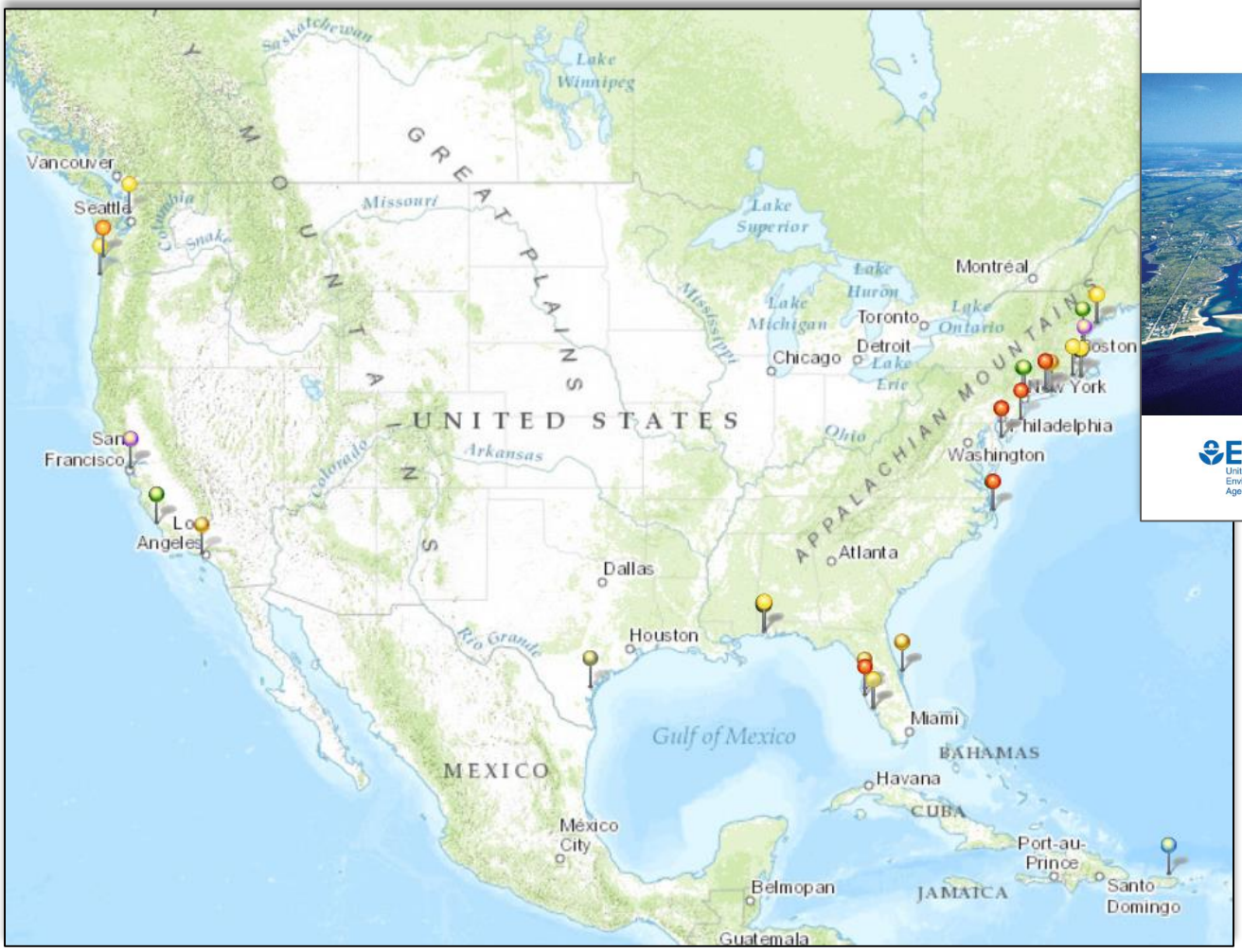
Collaborate with Partners

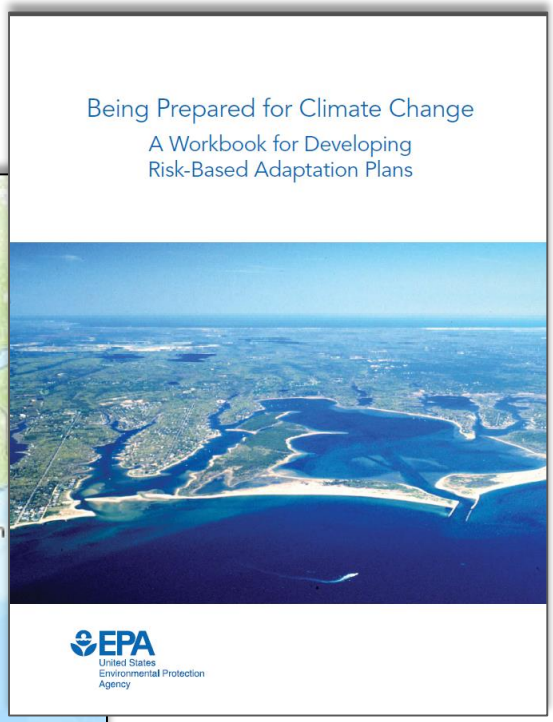
Climate Resilience Evaluation and Awareness Tool



Assess Risks and Evaluate Opportunities

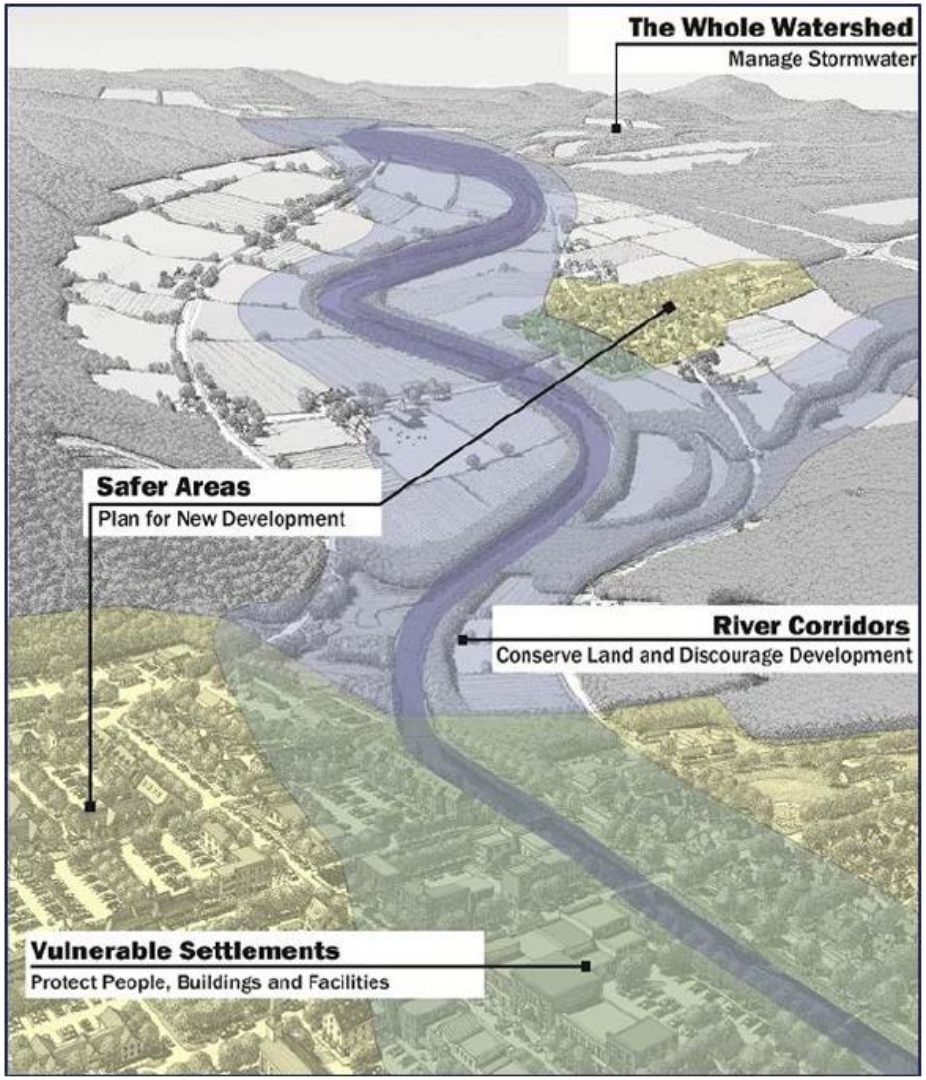
Climate Ready Estuaries





CRE Website:
http://www2.epa.gov/cre/being-prepared-climate-change-workbook-developing-risk-based-adaptation-plans/

EPA Flood Resilience Checklist



This graphic illustrates the four categories of approaches to enhance resilience to future floods. Credit: Vermont Agency of Commerce and Community Development.

EPA Website:
http://www.epa.gov/smartgrowth/sgia_communities.htm#rec1/

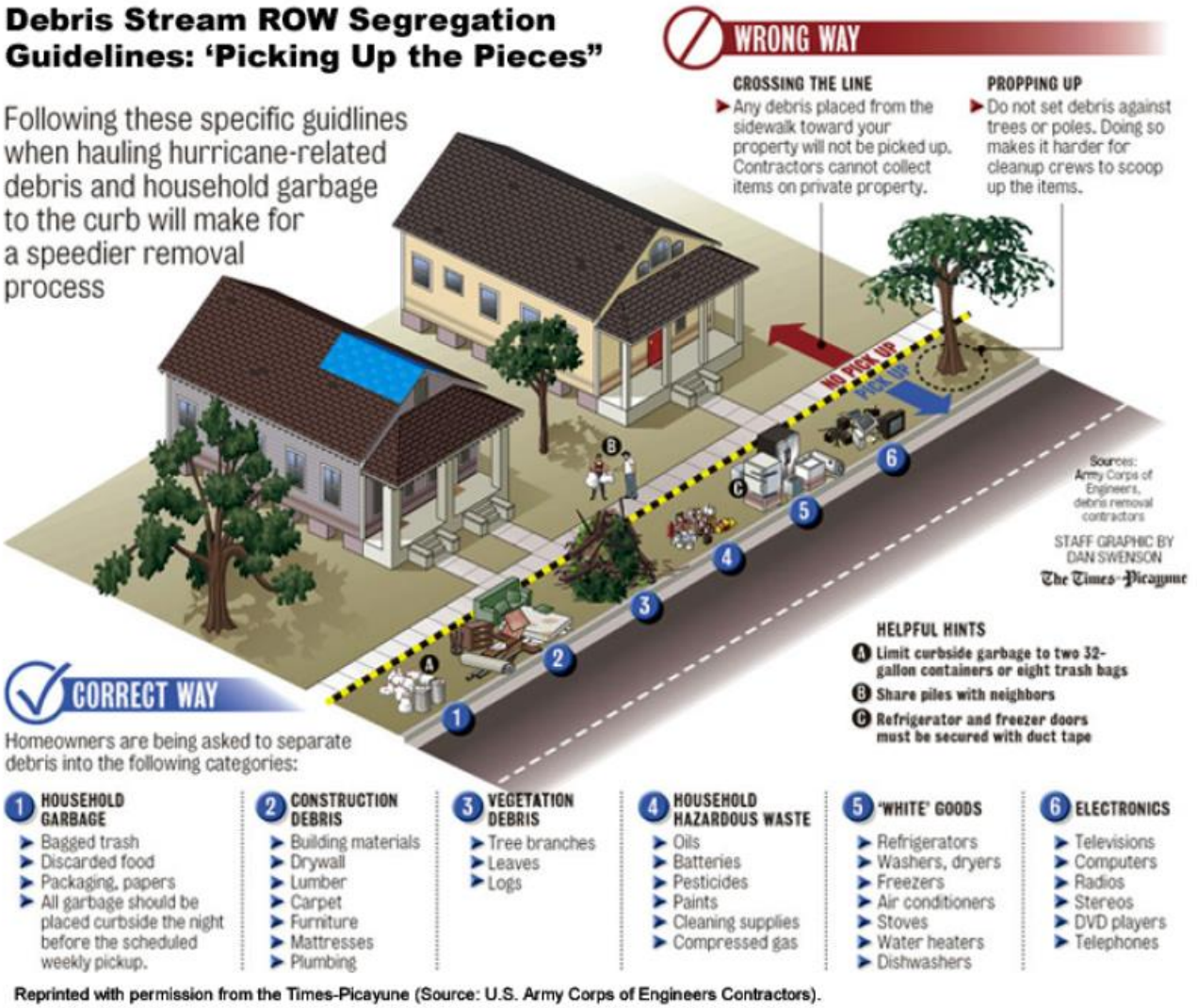
EPA Green Infrastructure

EPA Green Infrastructure website: http://water.epa.gov/infrastructure/greeninfrastructure/climate_res.cfm

EPA Stormwater Calculator

Stormwater Calculator Website:
http://www2.epa.gov/water-research/national-stormwater-calculator

EPA Debris Management



Debris Website:
http://www.epa.gov/wastes/conserve/imr/cdm/debris.htm

Case Study: Mainstreaming Climate

Superstorm Sandy shut down operations of a coastal wastewater treatment facility.

- Site recovery measures:
  - 17’ sea wall
  - elevate critical infrastructure
  - onsite power

+

- upstream green infrastructure
- coastal wetlands damaged by excess nitrogen
  - **Denitrification >> Resilience**

= Resilient Systems

THANK YOU

行政法人 國家災害防救科技中心
National Science and Technology Center for Disaster Reduction

From Climate Science to Adaptation Policy:
A Case of Disaster Impact Assessment in Taiwan

Shih-Yun Kuo, Ph.D.

Management and Socio-Economic System Division
Disaster Risk Assessment and Adaptation Strategy under Extreme Climate Project

National Science & Technology Center for Disaster Reduction (NCDR)
Taiwan

2014 The 1st Pan Pacific International Conference on Climate Change Adaptation
2014.9.29

Presentation Outline

1. The Threat—Climate Change Risks & Responses

- Current climate scientific research and adaptation policy in Taiwan

2. The Problem—Adaptation Bottleneck

- The implementation gap btw climate science & adaptation policy

3. The Case—Disaster Impact Assessment in TW

- How to construct future extreme climate events scenarios
- How to apply DIA in disaster adaptation policy

4. The Conclusion—Challenges Ahead!

- The potential of future work

- Current climate scientific research and adaptation policy in Taiwan

1. THE THREAT—CLIMATE CHANGE RISKS & RESPONSES

The Threat—
Climate Change Risks & Responses

The Changing Climate

- Temperature
- Precipitation
- Snow cover/sea ice
- Sea level
- Extreme Events

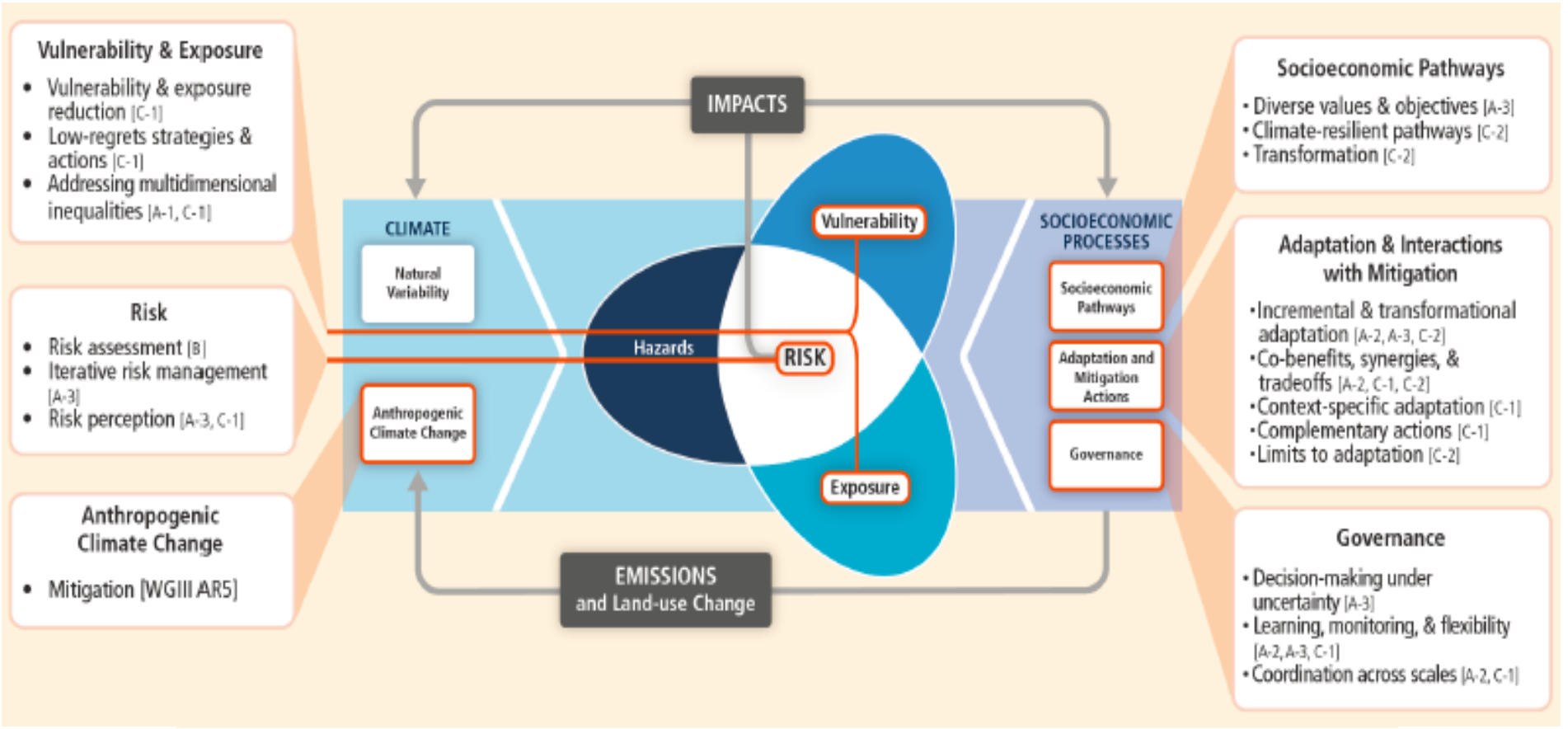
Widespread Impacts

- Physical systems
  (glaciers, rivers, coast)
- Biological systems
  (terrestrial, marine ecosys.)
- Human systems
  (food, livelihoods, health)

Source: AR5 WGI (IPCC, 2013), AR5 WGII (IPCC , 2014)

The Threat—
Climate Change Risks & Responses

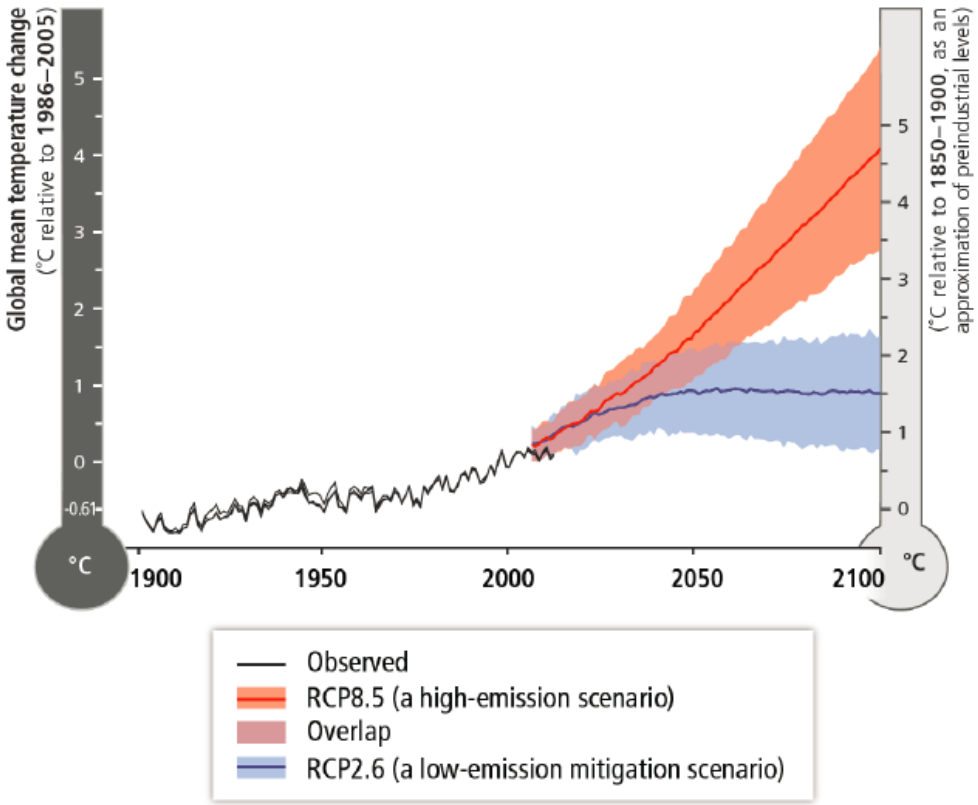
- Taking necessary responses to reduce & manage risks



Source: AR5 WGII
(IPCC , 2014)

The Threat—
Climate Change Risks & Responses

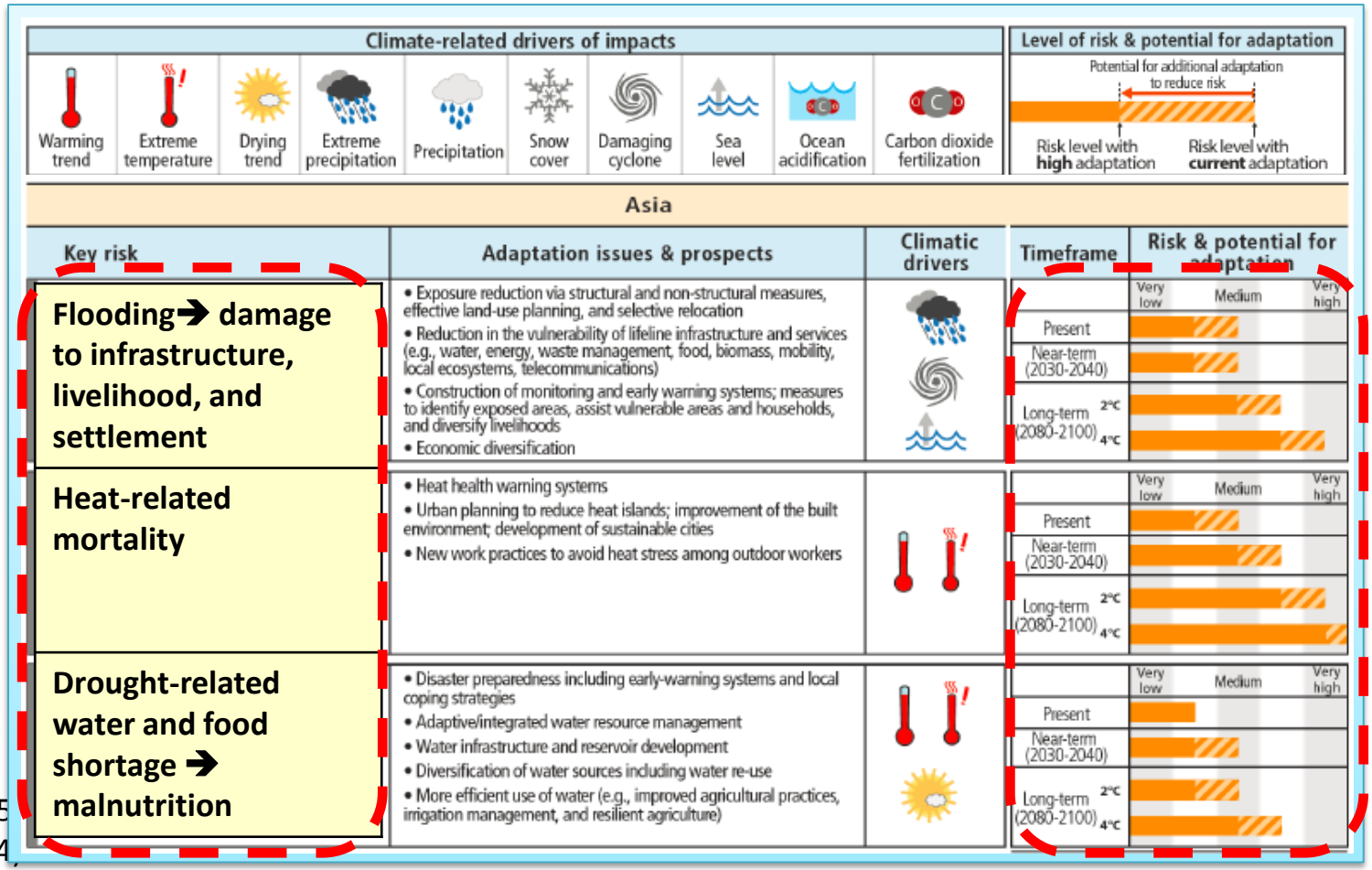
- Climate-related risks are reduced substantially under the low emissions scenario (RCP2.6) ➔ **Mitigation is important**
- Some risk from adverse impacts remains ➔ **Adaptation is still necessary!**



Source: AR5 WGII
(IPCC , 2014)

The Threat—
Climate Change Risks & Responses

- Climate-related risks in Asia

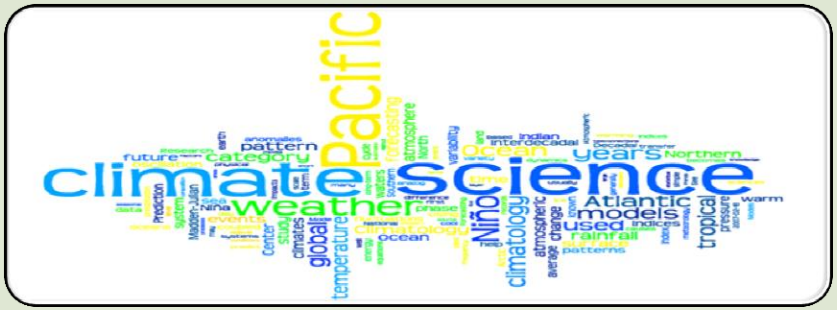


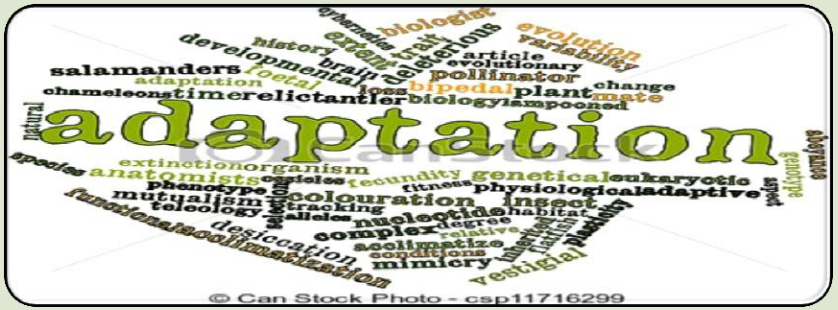
Risk levels in the long term are high with current adaptation

Source: AR5
(IPCC , 2014)

The Threat—
Climate Change Risks & Responses

- Taiwan's efforts to respond to climate change risks.





Climate Science (MOST)

- 3 Climate Change Study Projects (MOST)
  (TCCIP, TaiCCAT, CCliCS)
- TW CC Science Report

Adaptation Policy (NDC)

- National Adaptation Strategy & Action Plan
- Local Climate Change Adaptation Plan Project

Source: AR5 WGI (IPCC, 2013), AR5 WGII (IPCC , 2014)

The Threat—
Climate Change Risks & Responses

- Taiwan Climate Change Science Report (2011)
  - Historical-present trend and future projection

Temperature

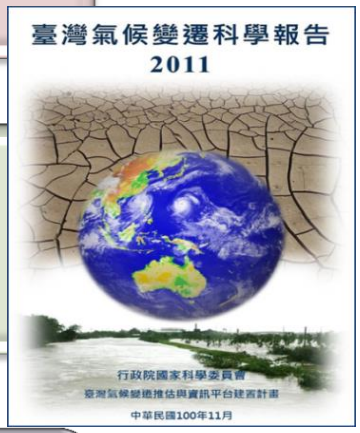
- The annual mean temperature in the flatland has **increased by 1.4℃** (1911-2009) 。
- High-T days ↑ ; extreme cold events ↓

Precipitation

- The annual total rain days has decreased
- The number of torrential rain days (daily rainfall ≥ 200 mm) has increased

Sea Level Rise

- The sea level has rose around a rate of 5.7mm yr-1(1993-2003)



Source: TW CC Science Report (MOST, 2011)

The Threat—
Climate Change Risks & Responses

- Climate variables projection by regions/seasons
  - (2080-2099/1980-1999)(AR4 A1B Scenario)

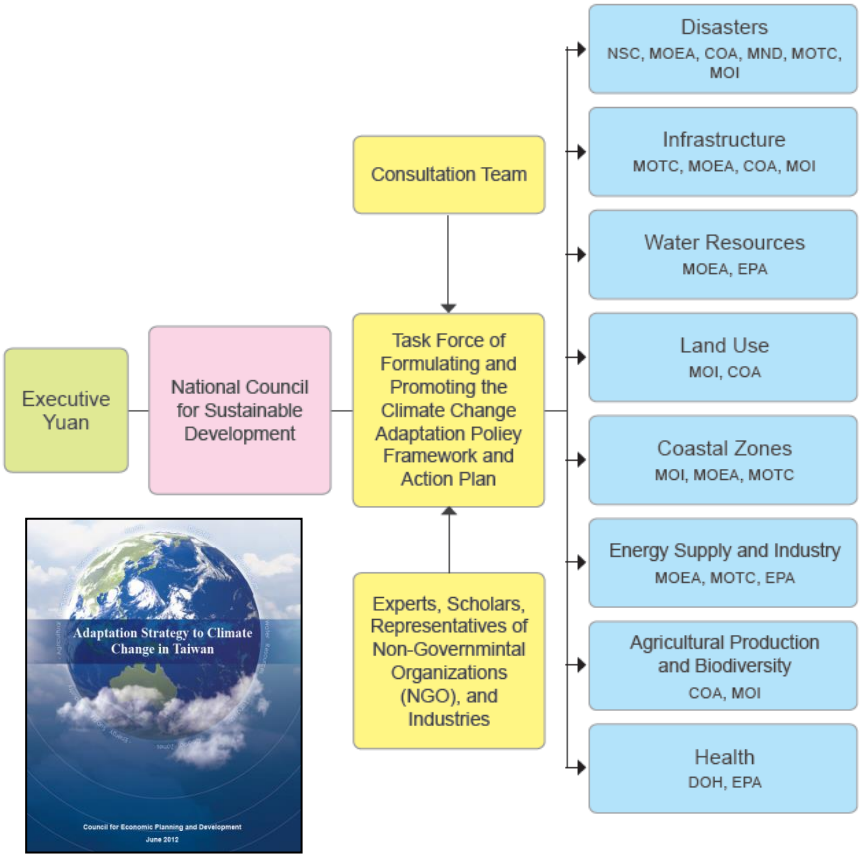
		Temperature change (°C)							Precipitation change (%)						
區域	季節	最小	10	25	50	75	90	最大	最小	10	25	50	75	90	最大
North	冬(DJF)	1.9	1.9	2.1	2.7	3.1	3.4	3.8	-44	-29	-20	-13	-3	7	33
	春(MAM)	1.7	1.8	2.2	2.6	2.9	3.4	3.9	-31	-24	-14	-8	6	17	36
	夏(JJA)	1.7	1.8	2.2	2.7	3.0	3.3	4.0	-15	-12	-1	14	29	46	64
	秋(SON)	1.6	1.8	2.2	2.6	3.1	3.3	3.8	-33	-25	-10	8	21	28	34
Central	冬(DJF)	1.8	1.9	2.0	2.6	3.0	3.3	3.7	-49	-33	-22	-15	-4	6	
	春(MAM)	1.6	1.8	2.1	2.6	2.9	3.3	3.8	-36	-25	-16	-10	3	1	
	夏(JJA)	1.8.	1.8	2.2	2.7	3.0	3.2	4.0	-15	13	2	14	26	6	
	秋(SON)	1.6	1.8	2.2	2.6	3..0	3.3	3.7	-34	-23	-7	11	25	3	
South	冬(DJF)	1.7	1.7	2.0	2.5	2.9	3.2	3.4	-47	-34	-22	-13	-5	5	
	春(MAM)	1.5	1.8	2.0	2.5	2.8	3.0	3.6	-41	-26	-21	-14	-5	2	
	夏(JJA)	1.7	1.7	2.2	2.5	2.9	3.2	4	-20	-19	7	16	26	6	
	秋(SON)	1.5	1.7	2.1	2.6	2.9	3.1	3.6	-28	21	-8	13	25	36	55
East	冬(DJF)	1.8	1.8	2.0	2.6	3.0	3.3	3.7	-44	-31	-20	-12	-3	5	17
	春(MAM)	1.5	1.8	2.1	2.5	2.8	3.3	3.8	-37	-25	-18	-11	1	20	36
	夏(JJA)	1.7	1.7	2.2	2.6	2.9	3.2	4.0	-17	-15	3	15	26	57	64
	秋(SON)	1.6	1.8.	2.1	2.6	3.0	3.2	3.7	-30	-23	-10	10	23	33	43

- **Wet season (summer) is wetter**
- **Dry season (winter) is drier**

Source: TW CC S
Report (MOST, 2

The Threat—
Climate Change Risks & Responses

- National CC Adaptation Policy Framework (2012)



- National CC Adaptation Action Plan (2013-2017)

1. Constructing enabling conditions for climate change adaptation
2. Climate change risk assessment and planning
3. Comprehensive adaptation projects for high-risk areas (Demo: north metropolitan)
4. Sectorial action plans (8 sectors)

- The implementation gap btw climate science & adaptation policy

2. THE PROBLEM—ADAPTATION BOTTLENECK

The Problem—
Adaptation Bottleneck

- The foremost climate change risk in Taiwan: **Disaster**

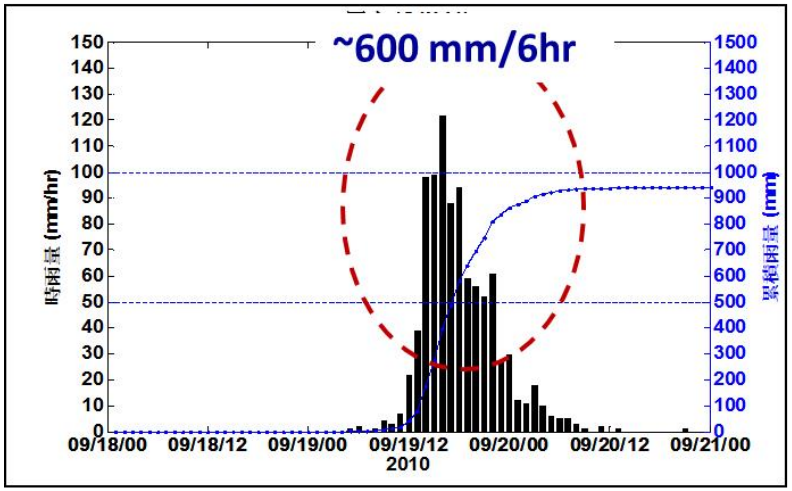
Why is disaster prioritized as the foremost risk?

- **The increase of extreme events is evident in recent 10 years. (scientific evidence)**
  - typhoon with extreme rainfall
  - 24-48 hrs accumulated rainfall near world record
- **Disasters will affect other sectors (high relevancy)**
- **The society views disaster reduction as an important issue (political correctness)**

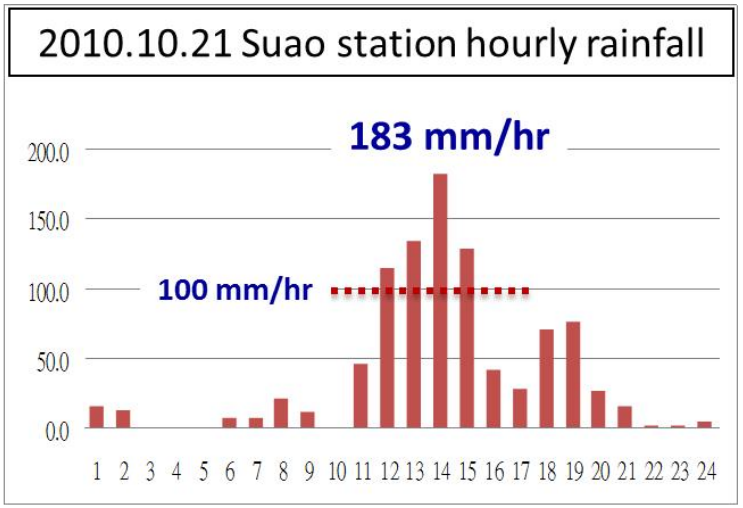
The Problem—Adaptation Bottleneck

- Extreme events may magnify **intensive disaster risk**

Typhoon Fanapi (2010)



Typhoon Megi (2010)



The Problem—
Adaptation Bottleneck

- National CC Adaptation Policy— **Disaster Sector**

What are the characteristics of these strategies?

- Based on genetic scientific information ➔ On the initial stage of policy making process ➔ collecting scientific evidence and conducting assessment
- More with the UNDP's APF approach (bottom-up) ➔ Mainstreamed into current disaster management policy ➔ reducing vulnerability and building capacity (No-regret policy)
- **Low relevancy** between climate science and resulting adaptation policies

Strategies

- Assessing climate change disaster risk and identifying high disaster risk areas
- Enhancing the integration of early warning information systems
- Reviewing & evaluating the vulnerabilities and prevention capacities and reinforcing disaster prevention and protection plans for major public construction infrastructure
- Pay more attention to the impact of climate change on major construction
- Carrying out comprehensive river basin management
- Strengthening capacities for responding to the impact of extreme weather, opening the risk information of impacted and endangered areas, and carrying out disaster reduction education, early warning, and drills

The Problem—Adaptation Bottleneck

- The adaptation bottleneck occurs
  - "where decision-makers have reached a high level of awareness of climate change in the general sense, and frequently understand the case for adaptation, but **have difficulty in identifying and implementing specific adaptation policies and measures** in the way they would in more familiar decision areas."
  - A lack of awareness of vulnerability to current or future climate (mean and variability, extremes)

Source: UKCIP (2004)

The Problem—Adaptation Bottleneck

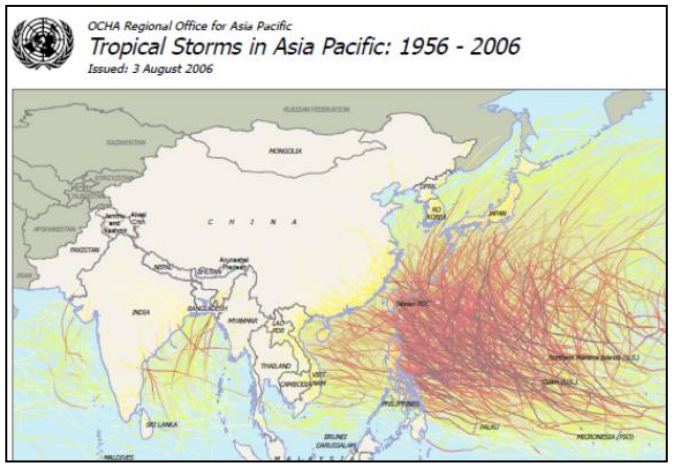
- How to overcome the adaptation bottleneck?
  - Scientific information is decided by users (risk analysts and policy makers) **WHAT**
    - Clarify what climate scientific information is relevant to impact assessment and adaptation policy (required info.)
  - Scientific knowledge translation & communication **HOW**
    - An understanding of generic climate change impacts needs to be translated into decision-making processes and action

- How to construct future extreme climate events scenarios
- How to apply DIA in disaster adaptation policy

3. THE CASE—DISASTER IMPACT ASSESSMENT IN TAIWAN

The Case—
Disaster Impact Assessment in Taiwan

- Basic disaster-related features of Taiwan
  - Mountainous island in west pacific
    - Small spatial scale (400x145km)
    - Complicated weather and climate system
  - Major hydro-meteorological hazards:
    - flooding, landslides, drought
    - key climate variable: precipitation
  - Meteorology and Hydrology
    - Uneven distribution of precipitation
    - Short rivers and rapid flows
    - River-basin features (landslides + flooding)



Disaster managers in Taiwan need to battle with disasters each year, what does "climate change" make it different?

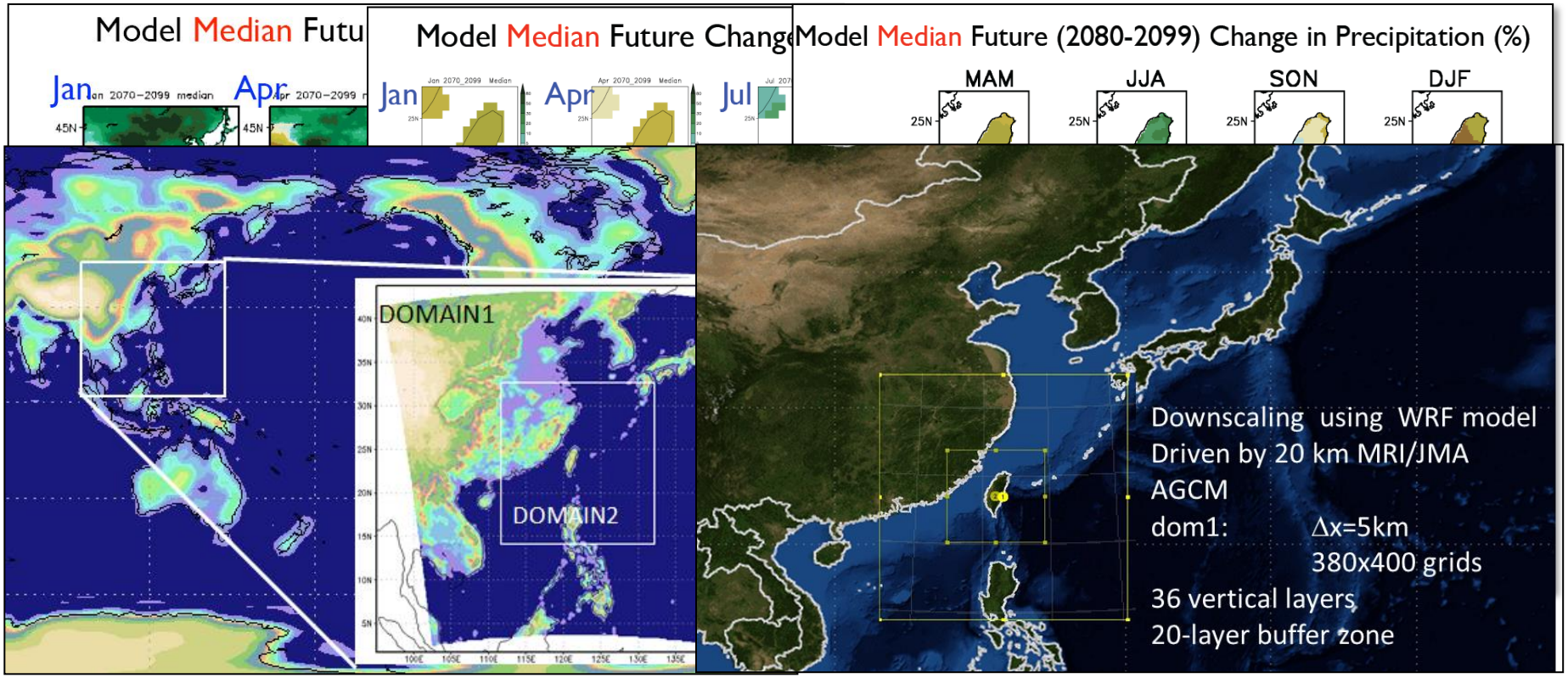
The Case—
Disaster Impact Assessment in Taiwan

- Traditional disaster management
  - Reactive perspective
  - Response management
  - Scenario based on the past experiences
    - Empirical analogy: what if typhoon Morakot happens again and in Taipei?

- What climate scientific info. can be provided?
  - High resolution projection data (GCM, statistical downscaling)
  - The context of the problem (**extent, temporal, spatial**)
  - The probability of the problem (uncertainty ➔decision)
  - Extreme scenario and data (dynamic downscaling)

The Case—
Disaster Impact Assessment in Taiwan

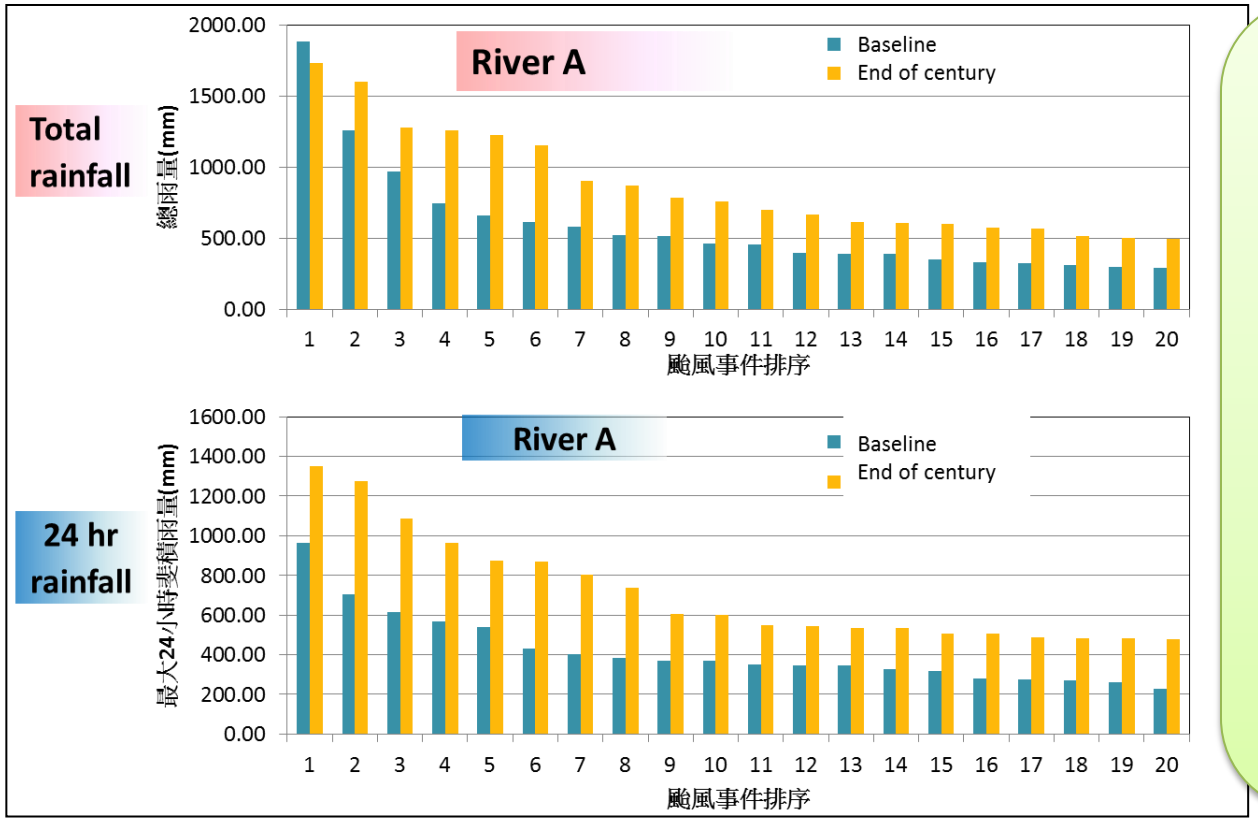
- **T**aiwan **C**limate **C**hange Projection & **I**nformation **P**latform (**TCCIP**)
  - provide High Resolution (5Km x 5Km) obs. & proj. data



The Case—
Disaster Impact Assessment in Taiwan

- Constructing future extreme climate events scenarios
  - Top 10 typhoon events (comparing total or 24hr rainfalls between baseline period and end of the century period)

1



Disaster adaptation policy

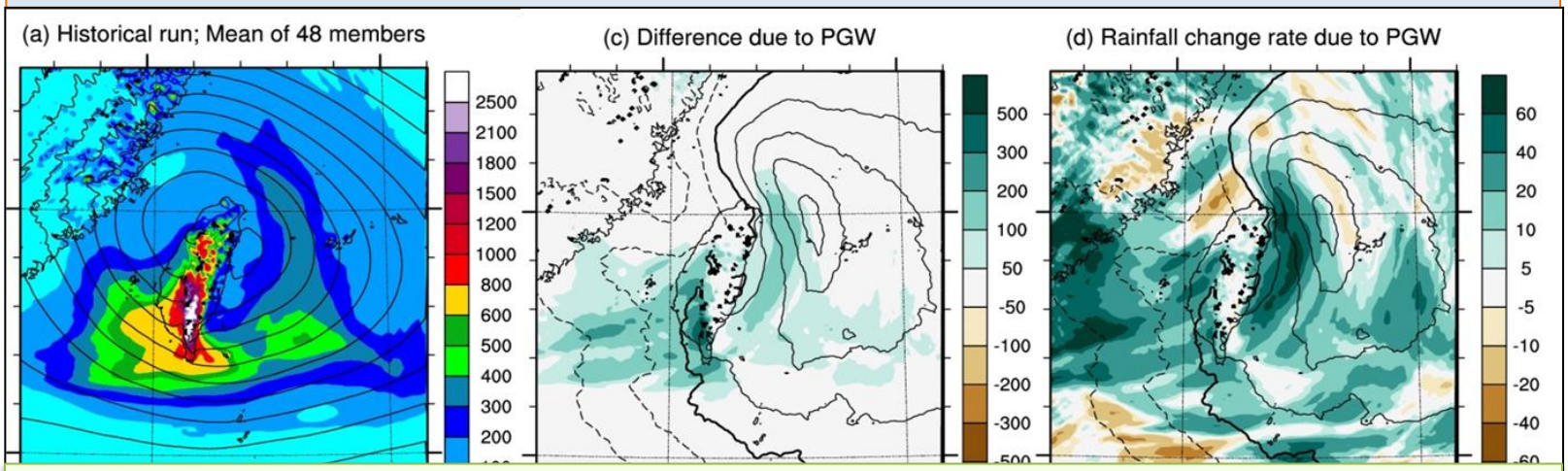
- **Information**: know the possible magnitude of the worse case of extreme rainfall typhoons
- **Policy**: adjust the standard/threshold
- **Limitation**: single model (uncertainty)

The Case—
Disaster Impact Assessment in Taiwan

- Constructing future extreme climate events scenarios
  - 2 – Pseudo global warming (PGW) historical typhoon event reenacting experiment
    - What if Typhoon Morakot happens in a warming scenario?

$$C_{PGW} = C_{history} + (\overline{C}_{future} - \overline{C}_{present})$$

$\overline{C}$: Climatology of 30 day mean; $C = T \cdot RH \cdot U \cdot V \cdot \Phi \cdot SST$



- Flatland area: rainfall and rainfall change rate increase (20-40%)
- Mountainous area: rainfall increases

The Case—
Disaster Impact Assessment in Taiwan

- Applying DIA in disaster adaptation policy
  - River flow simulation of the top 10 heavy-rainfall typhoons for five river basins

3

流域	淡水河	大甲溪	濁水溪	Tseng-Wen River	高屏溪
1979-2003	561.24 mm	511.19 mm	420.87 mm	345.12 mm	462.25 mm
2015-2039	424.75 mm	472.56 mm	458.69 mm	374.87 mm	425.03 mm
2075-2099	448.76 mm				

	TOP1	TOP2	TOP3	TOP4	TOP5	TOP6	TOP7	TOP8	TOP9	TOP10
基期	13531.38	7719.586	3156.794	3780.836	5441.979	3387.93	3856.473	1311.433	3507.61	2343.363
近未來	11782.82	11349.87	6750.627	7840.786	3367.139	5758.54	7926.844	4445.437	2353.962	4801.892
世紀末	18891.62	15937.19	11805.61	10783.4	12125.96	11170.08	10710.55	7011.56	5973.875	7021.806

Disaster adaptation policy

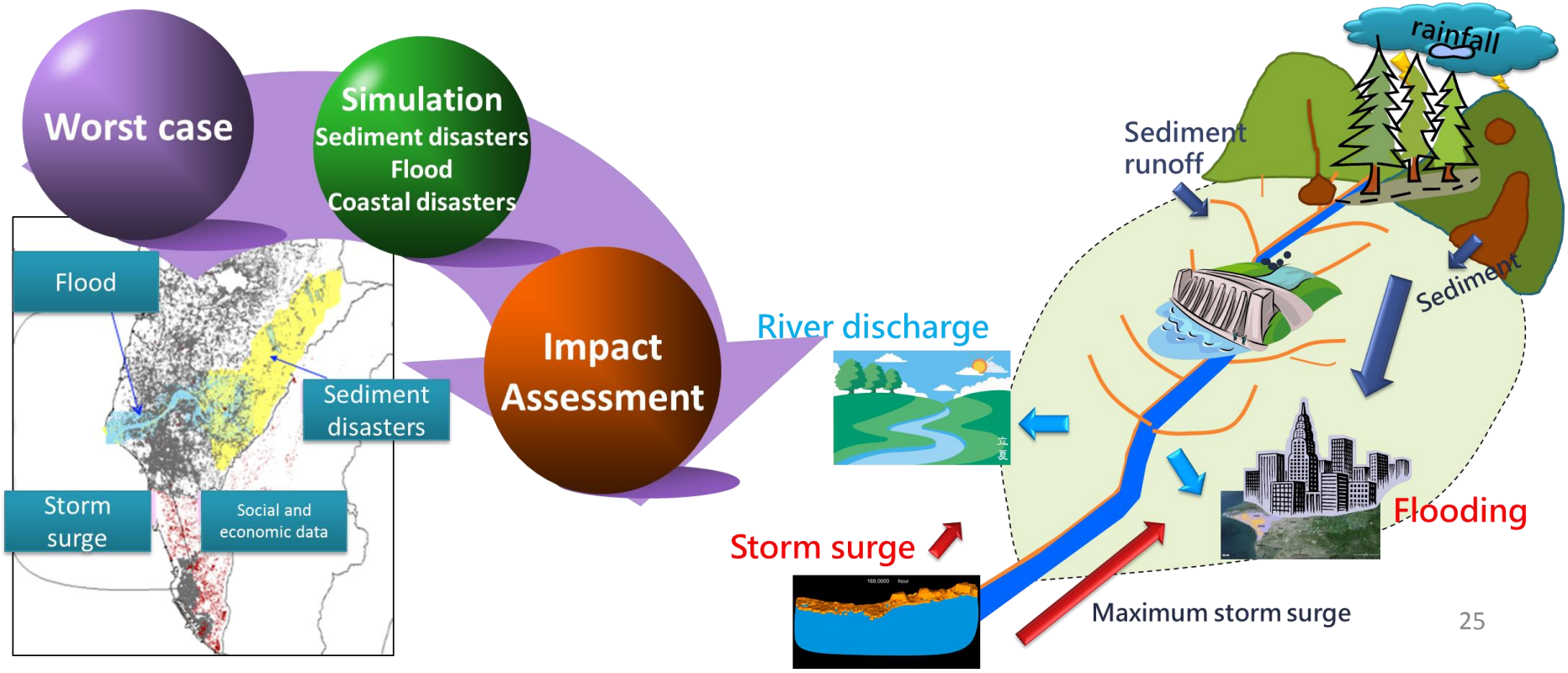
- **Information**: know the potential risk of flooding (increasing frequency of overflowing)
- **Policy**: adjust the designed flow
- **Limitation**: single model (uncertainty)

Xinzhong water level station (designed flow: 9890cms)

The Case—
Disaster Impact Assessment in Taiwan

- Applying DIA in disaster adaptation policy
  - The disaster impact assessment of comprehensive river basin under the extreme climate scenario (Tseng-Wen)

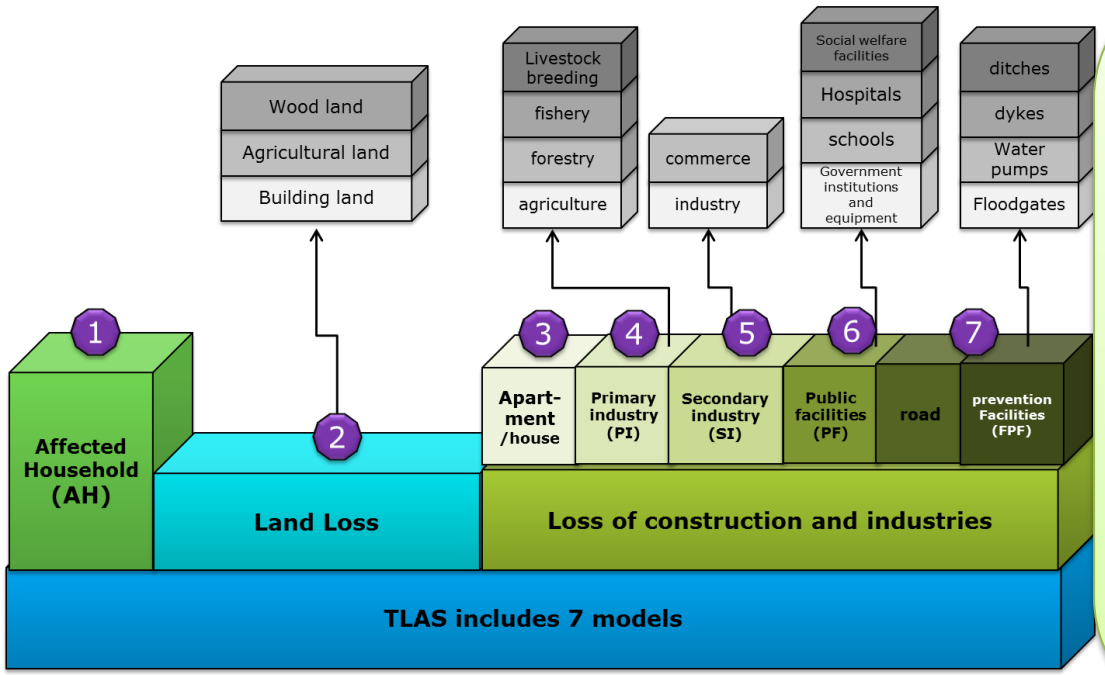
4



The Case—
Disaster Impact Assessment in Taiwan

- Applying DIA in disaster adaptation policy
  - The disaster impact assessment of comprehensive river basin under the extreme climate scenario (Tseng-Wen)
  - Taiwan Typhoon Loss Assessment System (TLAS)

4



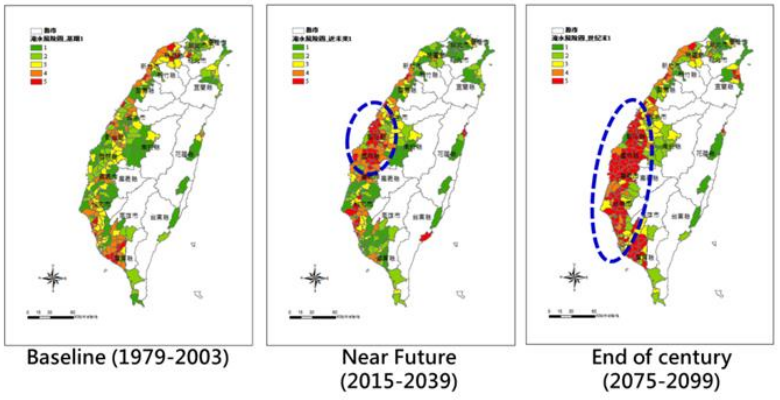
Disaster adaptation policy

- **Information**: know the potential risk and damage of flooding (flooding area)
- **Policy**: comprehensive river basin management (upstream-downstream)
- **Policy**: land use policy
- **Limitation**: single model (uncertainty)

The Case—
Disaster Impact Assessment in Taiwan

- Applying DIA in disaster adaptation policy
  - Climate-Related disaster Risk Maps (Flooding, slopeland disaster, coastal disaster, drought (public water usage))

5



Disaster adaptation policy

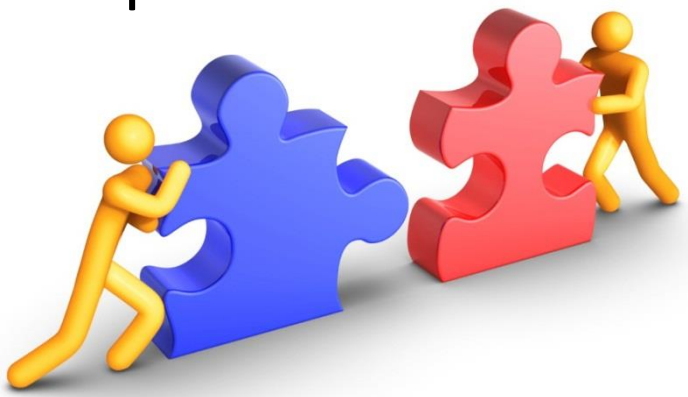
- **Information**: climate-change disaster risk information in terms of impact extents and spatial distribution (hot spot)
- **Policy**: env. and socio-eco vulnerability (population)
- **Policy**: land use/regional planning policy
- **Limitation**: single model (uncertainty), risk is relative concept

- The potential of future work

4. THE CONCLUSION—CHALLENGES AHEAD!

The Conclusion—Challenges Ahead!

- The collaboration between climate science, disaster risk assessment, and adaptation policy is an ongoing process.
- With the increasing understanding of climate change impacts (i.e., quantitative information with climate science models, disaster impact simulations), we expect to implement more sophisticated disaster risk management measures.



The Conclusion—Challenges Ahead!

- The potential of future work
  - For climate change impact and adaptation assessment
    - Produce more quantitative data (extent, temporal, spatial)
    - Continually improve the uncertainty of climate impact assessment
    - Science-based vulnerability and capacity assessment
    - Adaptation policy assessment
  - For adaptation policy makers
    - Strategies should trace back to original risk driving forces
    - MOST Sustainability Science Core Project—Integrated Risk Governance Project-Climate Change Disaster Risk (2015~)
  - For climate scientists, risk analysts, and policy makers
    - Translate scientific information accurately (context and uncertainty)

The Conclusion—
Challenges Ahead!

Climate Science Community, Disaster Impact Assessment Community, Adaptation Policy Community need to connect, communicate, and collaborate.

Thanks
for your attention

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