International Symposium on “Integrated actions for global water and environmental sustainability” Special session on IFI & IDI

An Operational Flood Early Warning System for regions with an insufficient observation network system and capacity development

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at JW Marriot Hotel, Medan, Indonesia

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ICHARM under the auspices of UNESCO, Japan

United Nations Educational, Scientific and Cultural Organization

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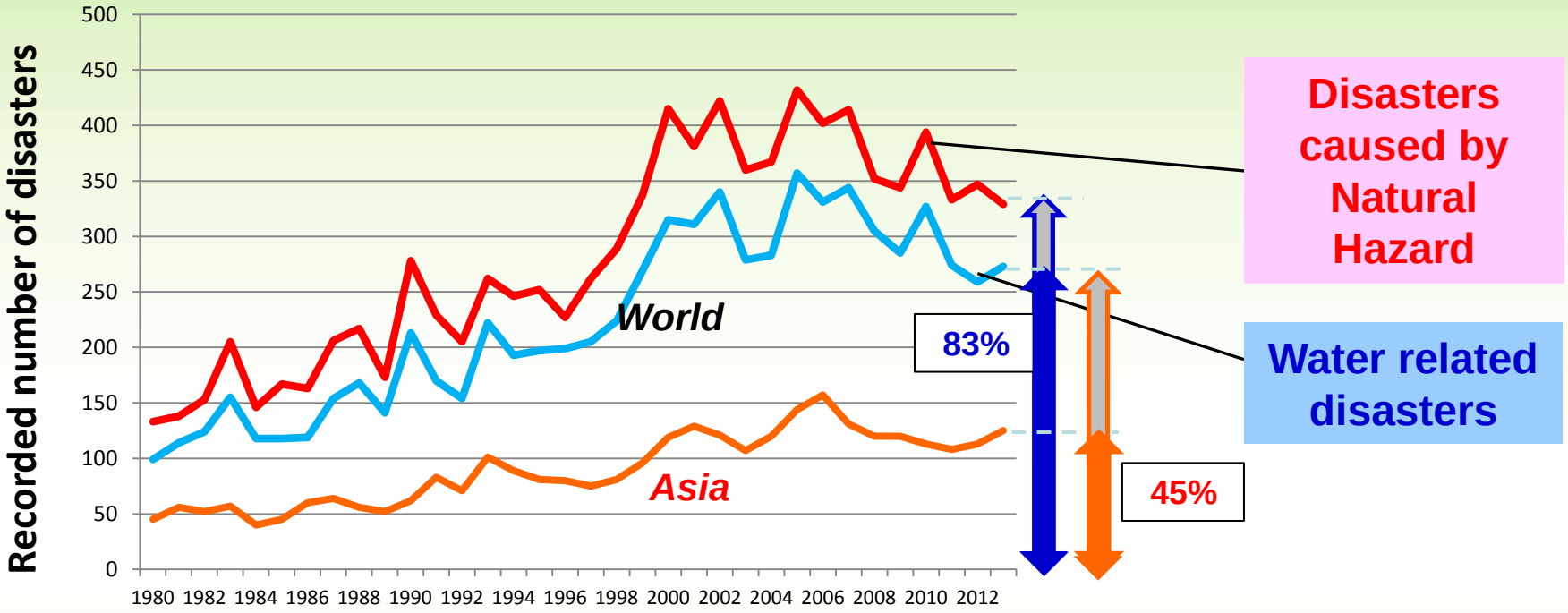
Contents

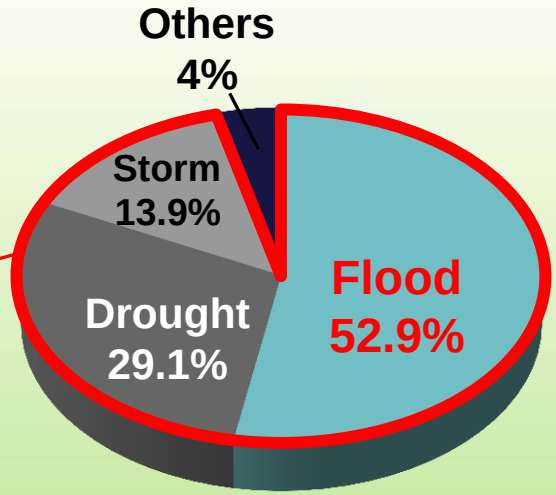
1. Increase of flood disasters and necessary measures
2. ICHARM approach for IFI
   - models (IFAS & RRI) and methodologies -
3. Case studies for Flood-EWS and Climate change analysis
4. Summary and discussion

Increasing extreme floods in the world

Increasing water related disasters (1980 – 2013)



Affected people by disasters (1980 – 2013)



Water related disasters 96%

Original data : EM-DAT (The OFDA/CRED International Disaster Database, Université Catholique de Louvain, Belgium)
CHARM, 2014

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Comprehensive adapting measures are necessary

Large-scale floods have been frequent in Asia recently.

Most of flood-prone regions are in the process of economic development, and effective measures are urgently needed to protect the effect of economic investment from large floods hazards.

Also it is concerned that flood hazard risk will be further increasing by intense rainfall in the future due to climate change.

To mitigate flood damage, comprehensive measures should be taken, such as 1)developing flood control facilities, 2)enforcing land use management and 3)establishing a flood early warning system (Flood-EWS).

ICHARM approach for IFI

IFI strategic structure

(Secretary: ICHARM)

Integrated Water Resources Management (IWRM)

Sendai framework

SDGs

UNCCC COP21

Integrated Flood Management (IFM)

Minimizing
social, environmental and economic risks

Maximizing
net benefits from the use of flood plains

IFI implementation steps

inter-disciplinary, trans-sectoral and basin-wide approaches

climate change, changes in anthropogenic activities

Understanding of current status

magnitude of flood hazards
impact of development
(changes in exposure, vulnerability)
shortage of resources
Shortage of political will

Planning

stakeholder participation
cultural diversity
impact & cost/benefit assessment
decision making

Implementation

early warning systems
land use management
effective infrastructure development
institutional frameworks
building back better
enlightening people's awareness

Follow-up

risk re-analysis
clarifying problems
identifying areas to be strengthened

IFI supporting tools

database *(statistics of flood damages/benefits and flood management knowledge)*

science & technology *(monitoring technology, simulation tools, risk assessment methodology, clear indices)*

local, national, regional initiative *(IFI-LAC etc.)*

capacity building *(training courses)*

financial mechanisms *(economic analysis tools and methods)*

Focus Areas

Monitoring

Hazard Assessment

Exposure Assessment

Vulnerability assessment and capacity building

Finance and investment

Expected Stakeholders

IFI promoters (International organizations etc.)

Academic Society (universities, research institutes etc.)

Government (water, disaster)

Funding Agencies (ODAs, Banks, UN etc.)

DB operational supporters

Project investors & owners

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- ***Exposure Assessment***
- ***Vulnerability assessment and capacity building***
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- DB operational supporters
- Project investors & owners

ICHARM approach for IFI

1. For mitigating flood damages in consideration with climate change, hydrological/hydraulic simulation models and assessment methodologies are necessary for comprehensive planning and establishing a Flood-EWS.

   ＜ICHARM models＞

   ・IFAS (Integrated Flood Analysis System)

   ・RRI (Rainfall-Runoff-Inundation)　etc.

2. Supporting Local Practices (actual system operation) with Capacity Building

○ Challenges in developing regions

Insufficient observed (past and real time) data

→ Difficulty of flood forecasting
Can not assess flood risk
Can not plan useful countermeasures for the future

Limitation of budget

→ It takes long time to develop infrastructures to prevent and mitigate flood disaster
Need for cost to install flood forecasting system

Need for capacity building to manage and maintain necessary systems

○ Technical innovation

Global dataset is available (tentatively used during in-situ data are not available)

→ Global map (Elevation, Geology, land use)

→ Satellite rainfall data

Advancement of numerical ability

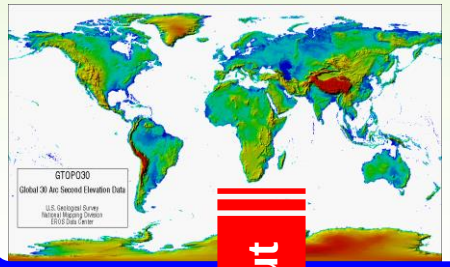
→ Distributed runoff hydrological model with parameters determined by grid based information can be applied in a short calculation time

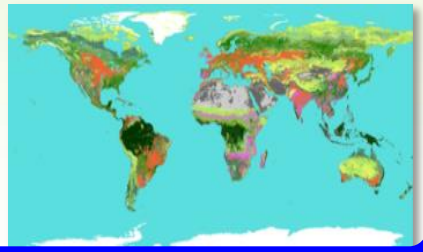
ICHARM -Early Warning System- Free software

with GIS &GUI functions http://www.icharm.pwri.go.jp/research/ifas/index.html

IFAS: Integrated Flood Analysis System for insufficient observed basin

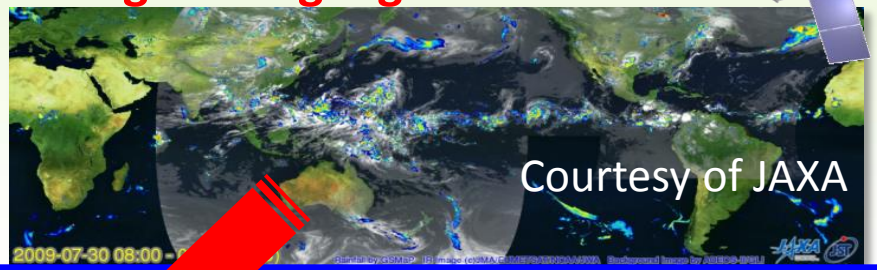
Global data: topography, land use, etc.





input

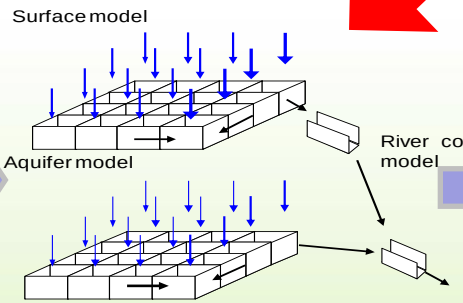
Import satellite rainfall and ground-gauged data



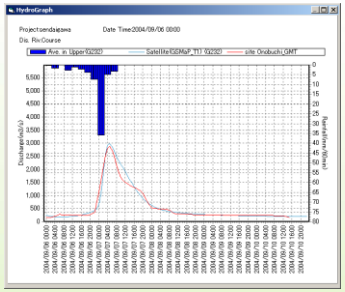
input

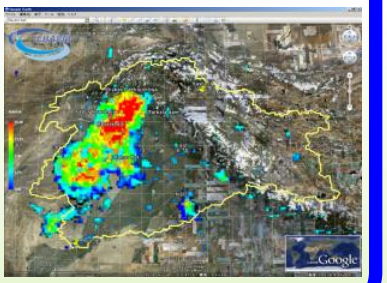
Run-off analysis by PWRI distributed tank model

Model creation



Output: River discharge, Water level, Rainfall distribution





Evacuate from dangerous areas

Judge by River management authorities

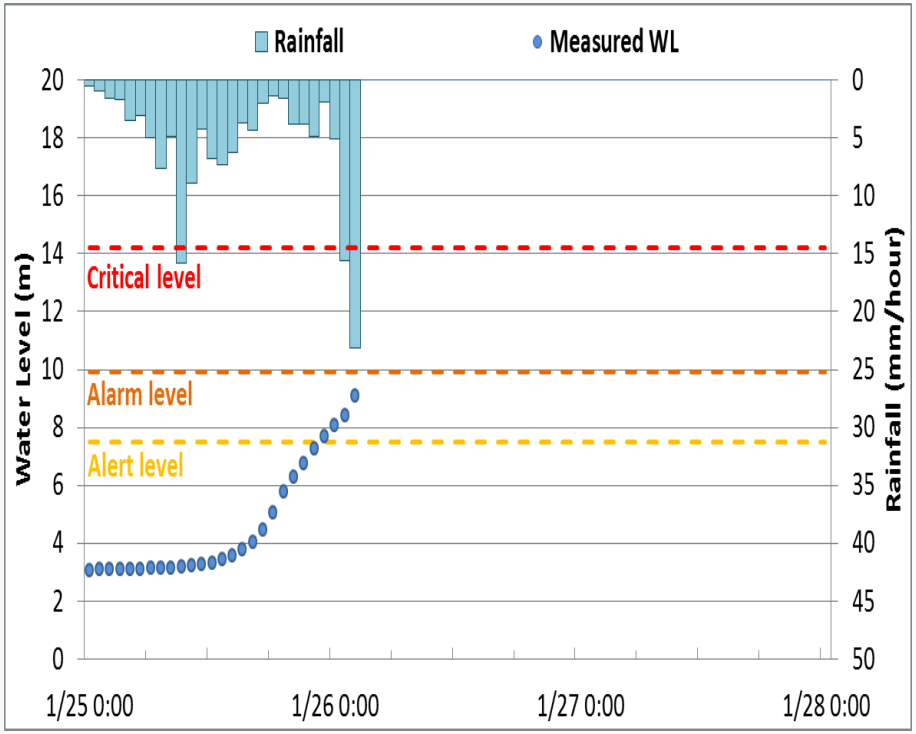
Alert message will be sent to river management authorities

Discharge reaches warning level

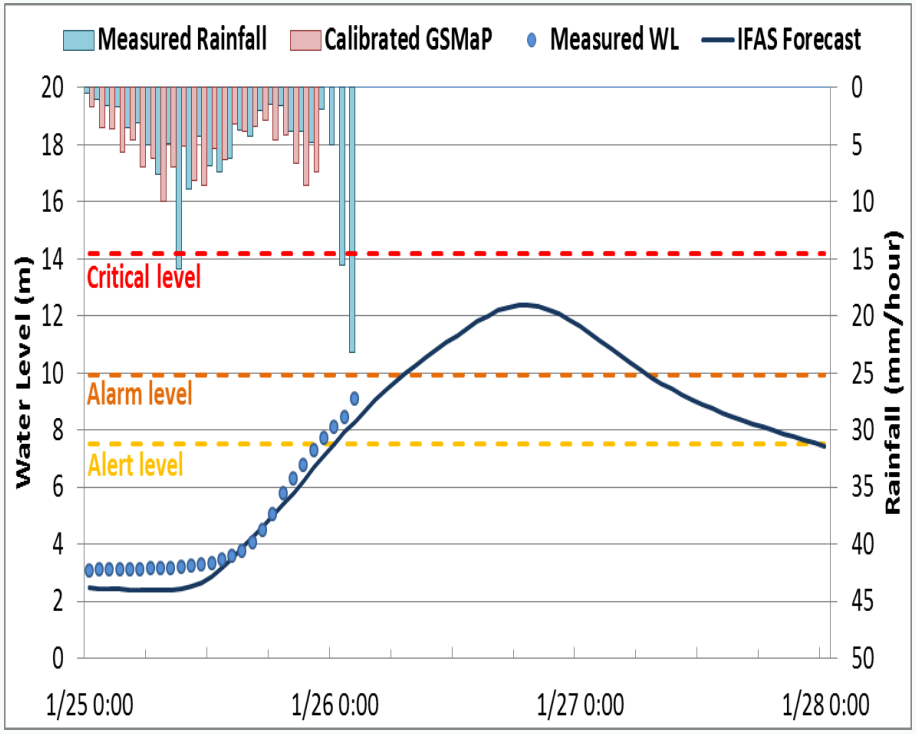
Available Information during flood

In particular, setting up a flood Flood-EWS is important to raise people's awareness to take necessary actions

Existing data



Forecasted info with a model



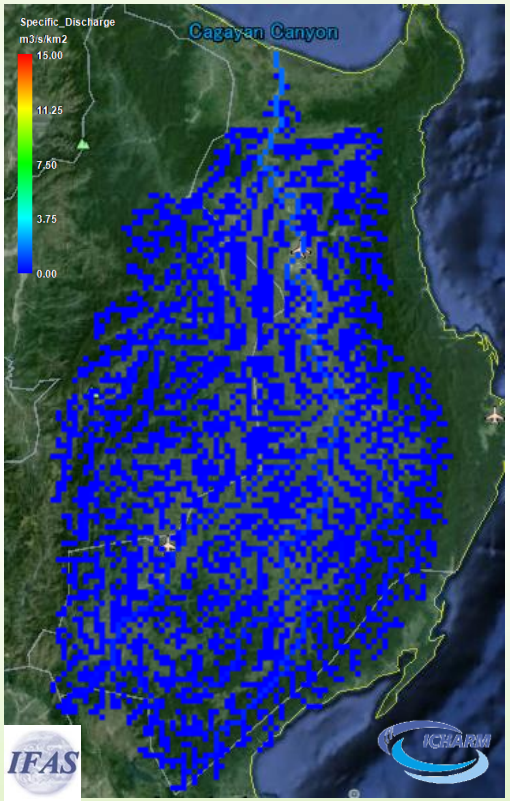
At Gamu (Jan. 26, 2006) in Cagayan river

IFAS Dynamic Map

Specific discharge, discharge and rainfall can be displayed as a basin-wide animation.
Users can easily realize the situation of whole basin and risk area.

Rainfall

discharge



Specific discharge

Specific discharge
($m^3/s/km^2$) means the value of discharge divided by upper catchment area.

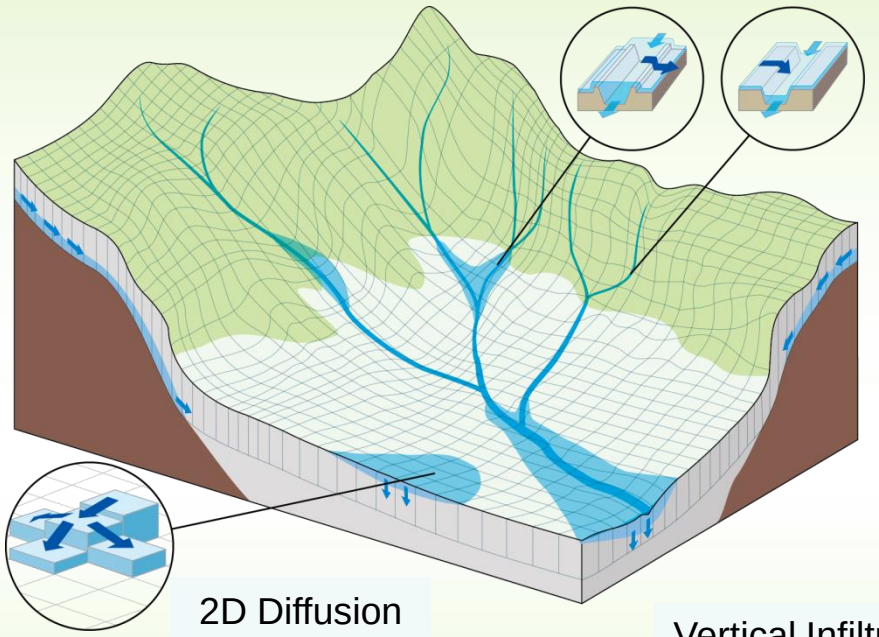
Specific discharge at Gamu ($12{,}200km^2$)
Critical level: 0.76
Alarm level: 0.39
Alert level: 0.23

ICHARM RRI (Rainfall-Runoff-Inundation) Model

Free software

Input

- Rainfall
- DEM
- Land Cover
- Cross Sec.



Output

- Discharge
- W. Level
- Inundation

- Two-dimensional model capable of simulating rainfall-runoff and flood inundation simultaneously
- The model deals with slopes and river channels separately
- At a grid cell in which a river channel is located, the model assumes that both slope and river are positioned within the same grid cell

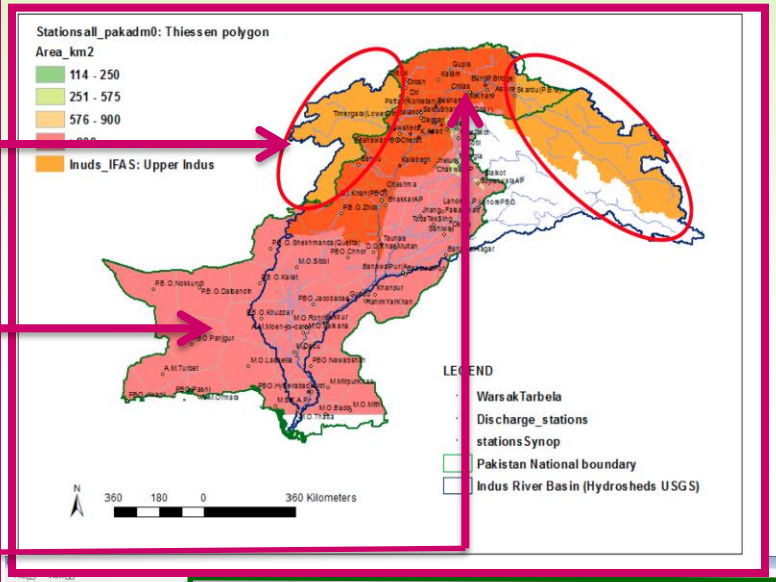
Sayama, T. et al.: Rainfall-Runoff-Inundation Analysis of Pakistan Flood 2010 at the Kabul River Basin, *Hydrological Sciences Journal*, 57(2), pp. 298-312, 2012.

ICHARM Indus-IFAS for UNESCO-Pakistan project

after Pakistan big flood in July, 2010 (2012-14)

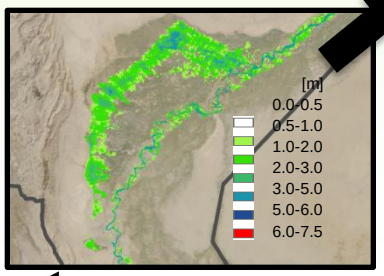
INPUT DATA CHALLENGES:

- *Lack of transboundary data*
- *Null-Low raingauges network density*
- *Uncertainty on snowmelt*



SUPARCO

Inundation area by **RRI**

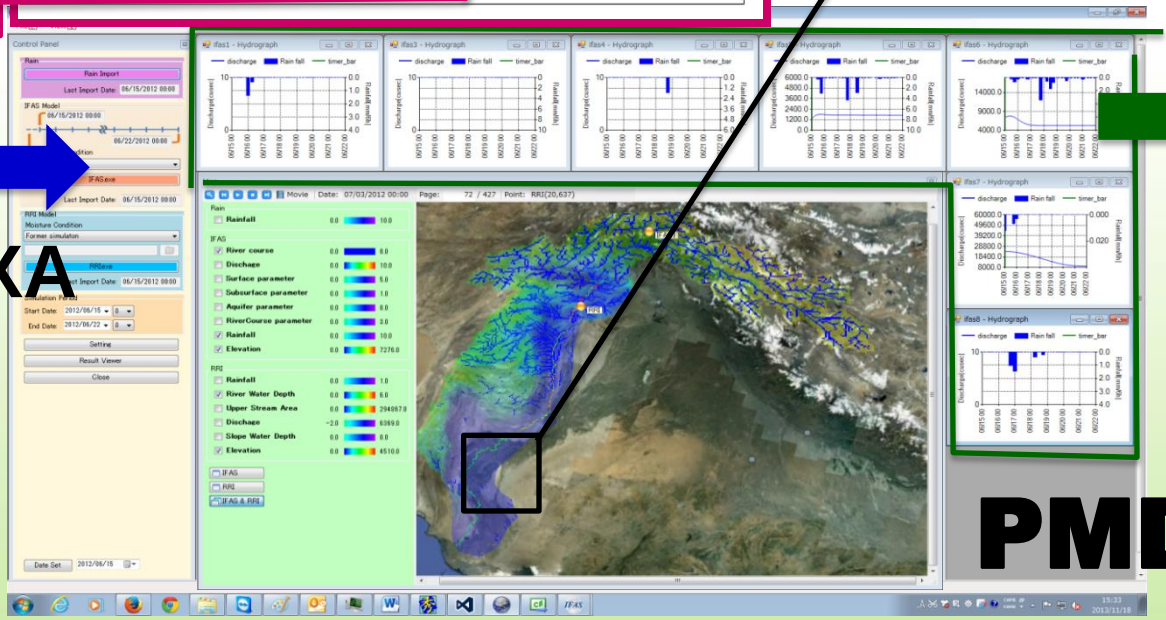


FLOOD HAZARD MAPPING

INPUT DATA :

- Rainfall data (ground-gauges, GSMaP, forecasted)
- **Real-time observed discharges**

JAXA



PMD

OUTPUT DATA:

- Rainfall distribu-tion maps
- Hydro-graphs at specified locations
- Inundation extents in mid-low Indus

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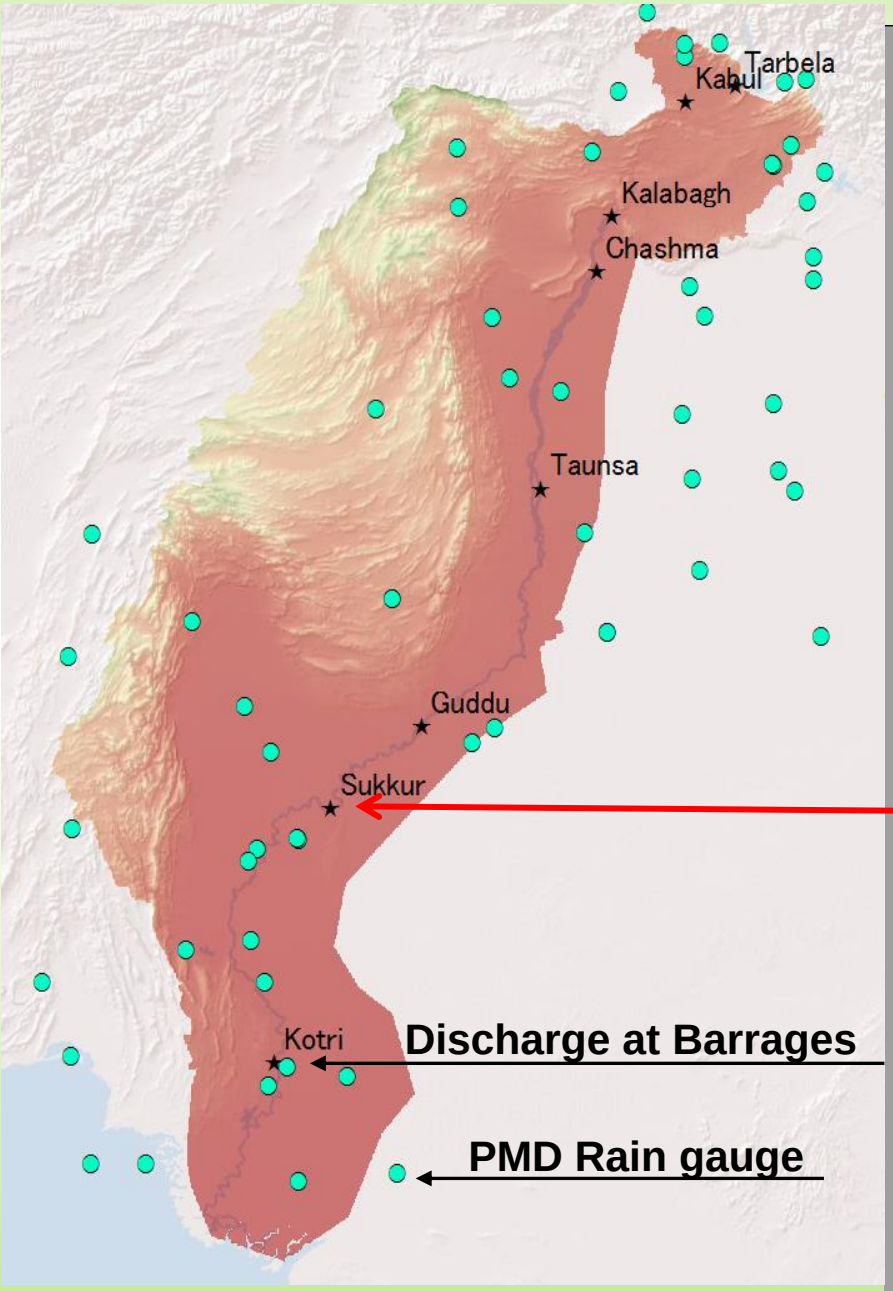
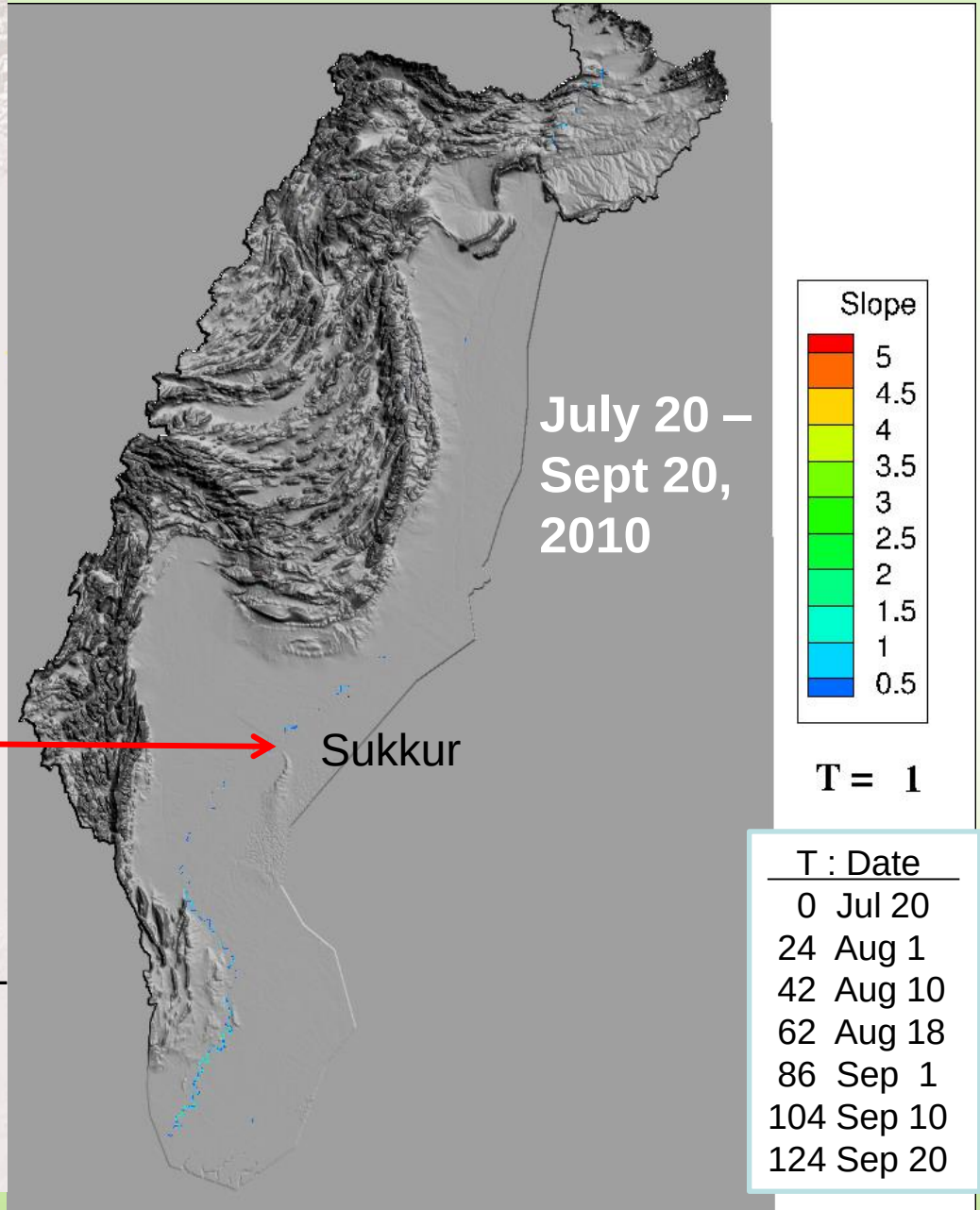
RRI simulation for UNESCO-Pakistan project





Capacity Building in UNESCO-Pakistan project

(2012-14)

6 Pakistani officers graduating from ICHARM/GRIPS MSc

Short-training course in Japan of 11 Senior Managers from Pakistan

ICHARM participation to international Workshop and Training in Pakistan

Indus-IFAS training in Pakistan

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Climate change analysis

A Climate Change Case Study Flow by ICHARM

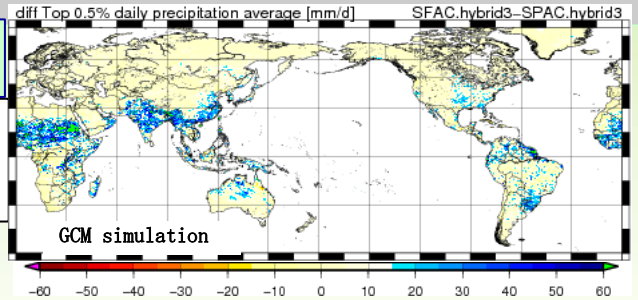
SOUSEI Program for Risk Information on Climate Change
気候変動リスク情報創生プログラム

(Flood Hazard & Risk Assessment)

Various GCM Scenarios on current/ future climate

MRI-AGCM etc.

Downscaling / Bias correction of GCMs
Statistical and dynamic downscaling



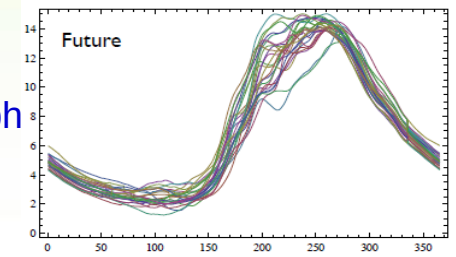
Uncertainty assessment

Basin scale rainfall information

Hydrological models
IFAS, RRI, etc.

Uncertainty assessment

Hydro graph



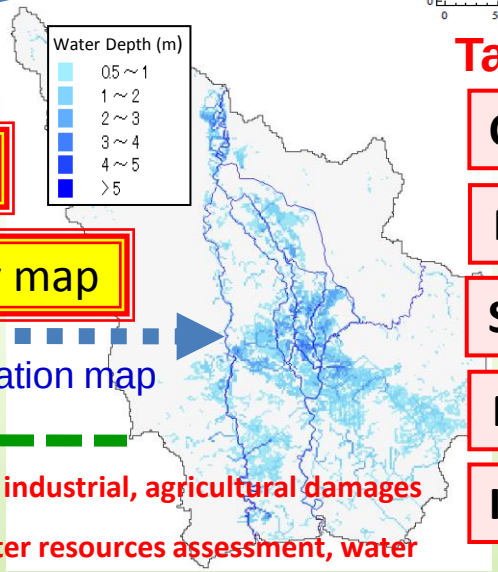
Analysis of **discharge** variation

Analysis of **water level** variation

Analysis of **inundation** variation

1/10,1/25,1/50

Flood frequency map



Inundation map

Socio-economic impact assessment

Flood risk House, industrial, agricultural damages

Drought risk Water resources assessment, water stress, risk partition

Disaster Risk monitoring indices

Target basins

- Chao Phraya, Thailand
- Pampanga, Philippines
- Solo, Indonesia
- Mekong, Cambodia
- Indus, Pakistan

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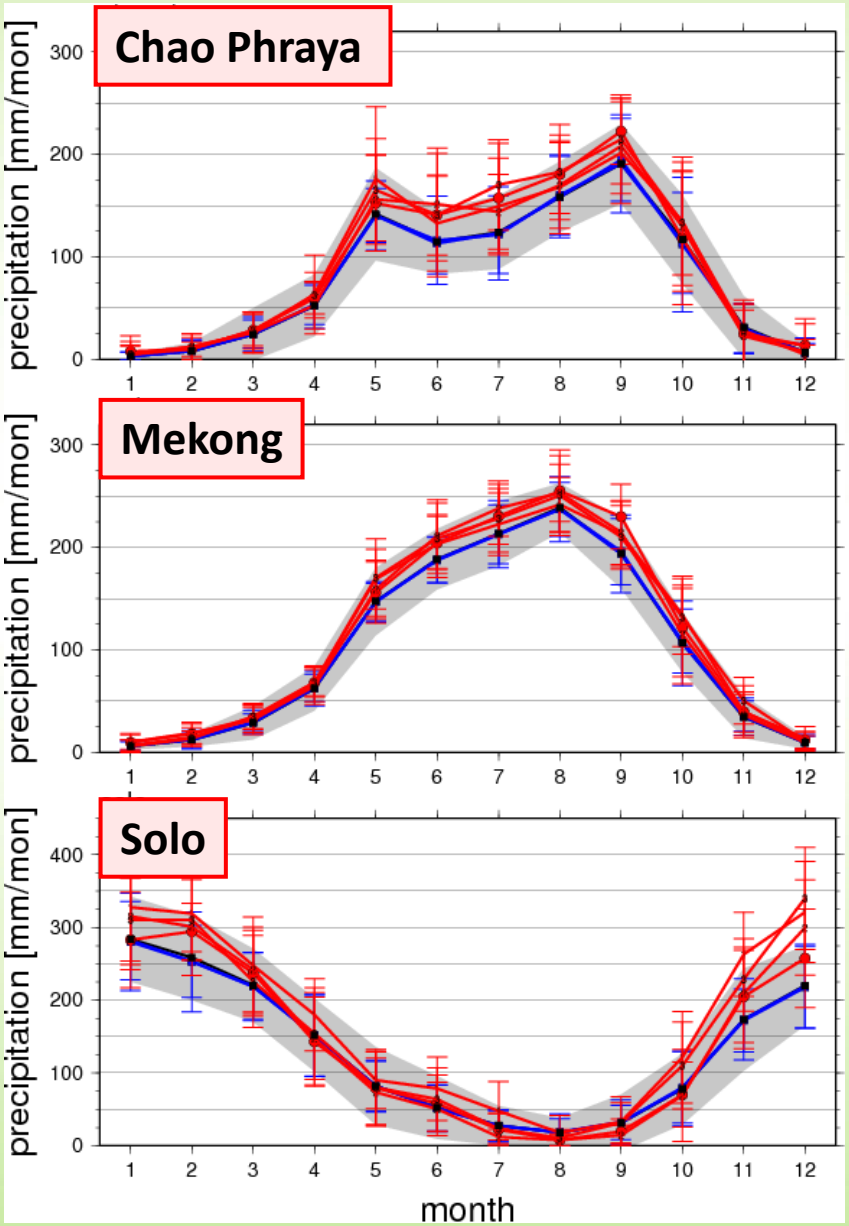
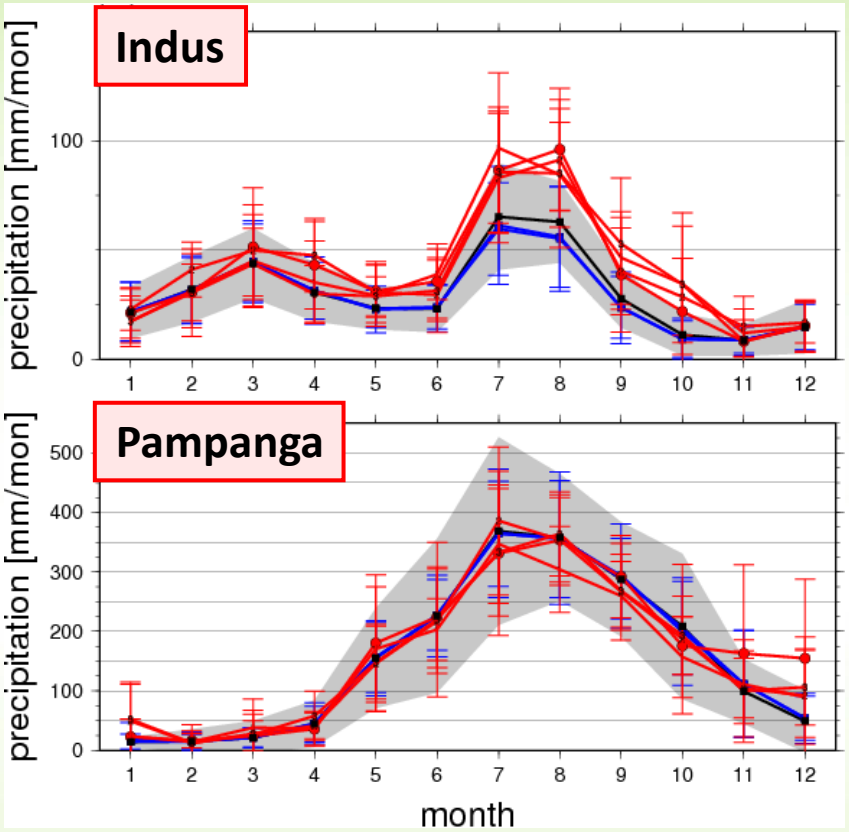
MRI-AGCM3.2S RCP8.5: different SSTs (Ensemble)





Observation, Present climate, Future climate

APHRO_PR_V1101 obs 1979–2003

MRI–AGCM3.2S YS AMIP 1979–2003 *2

MRI–AGCM3.2S YS RCP8.5 MME 2075–2099

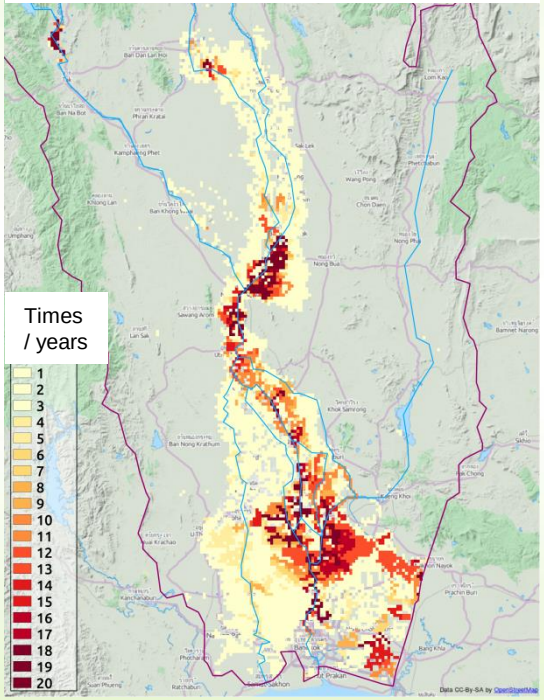
MRI–AGCM3.2S YS RCP8.5 c1 2075–2099

MRI–AGCM3.2S YS RCP8.5 c2 2075–2099

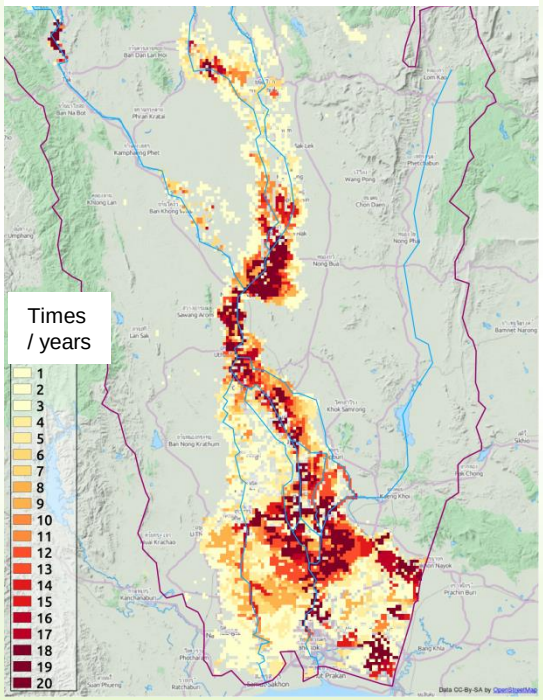
MRI–AGCM3.2S YS RCP8.5 c3 2075–2099

Inundation frequency analysis in Chao Phraya river basin between present and future climate (An example using MRI-AGCM 3.2S)

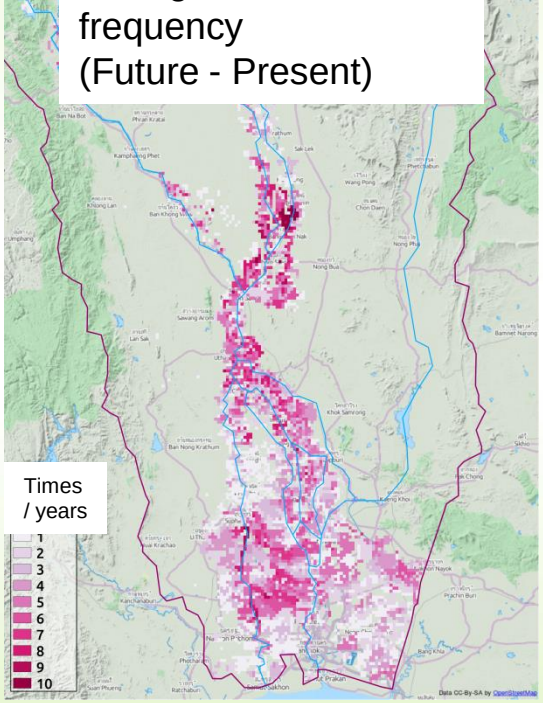
Present climate（1979-2003）



Future climate（2075-2099）



Change of Inundation frequency
(Future - Present)



Used MRI-AGCM3.2S (RCP8.5) and projected inundation frequency for 25 years

The study of climate change analysis was conducted under the framework of the “Precise Impact Assessments on Climate Change” of the Program for Risk Information on Climate Change (SOUSEI Program) supported by the Ministry of Education, Culture, Sports, Science, and Technology (MEXT), Japan.

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Summary and Discussion

1. ICHARM is supporting IFI to develop and provide hydrological simulation tools and assessment/analysis methodologies for flood disaster mitigation.

2. For setup and operation of a Flood-EWS, capacity building is also important.

3. Basically, Developing Observation Network and in-situ data collection systems are necessary to setup Flood-EWS with good accuracy

4. Sharing basic data, technologies and experiences are important for effective disaster management and efficient investment.
   IFI is a good platform to share our experiences.

Thank you for your attention