Water related disasters WG

Report on ICHARM activities in water related disasters risk reduction

WRD WG, the 4th JPTM, Sentinel Asia Step 3 in Hanoi, Viet Nam
March 8, 2017

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International Centre for Water Hazard and Risk Management (ICHARM)
under the auspices of UNESCO

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1. Expectation in Water related disasters WG
2. ICHARM activities
   1) Rainfall monitoring and flood forecasting
   2) Flood detection and analysis
   3) Data assimilation by satellite observation
   4) Climate Change analysis
   5) IFI (International Flood Initiative) activities

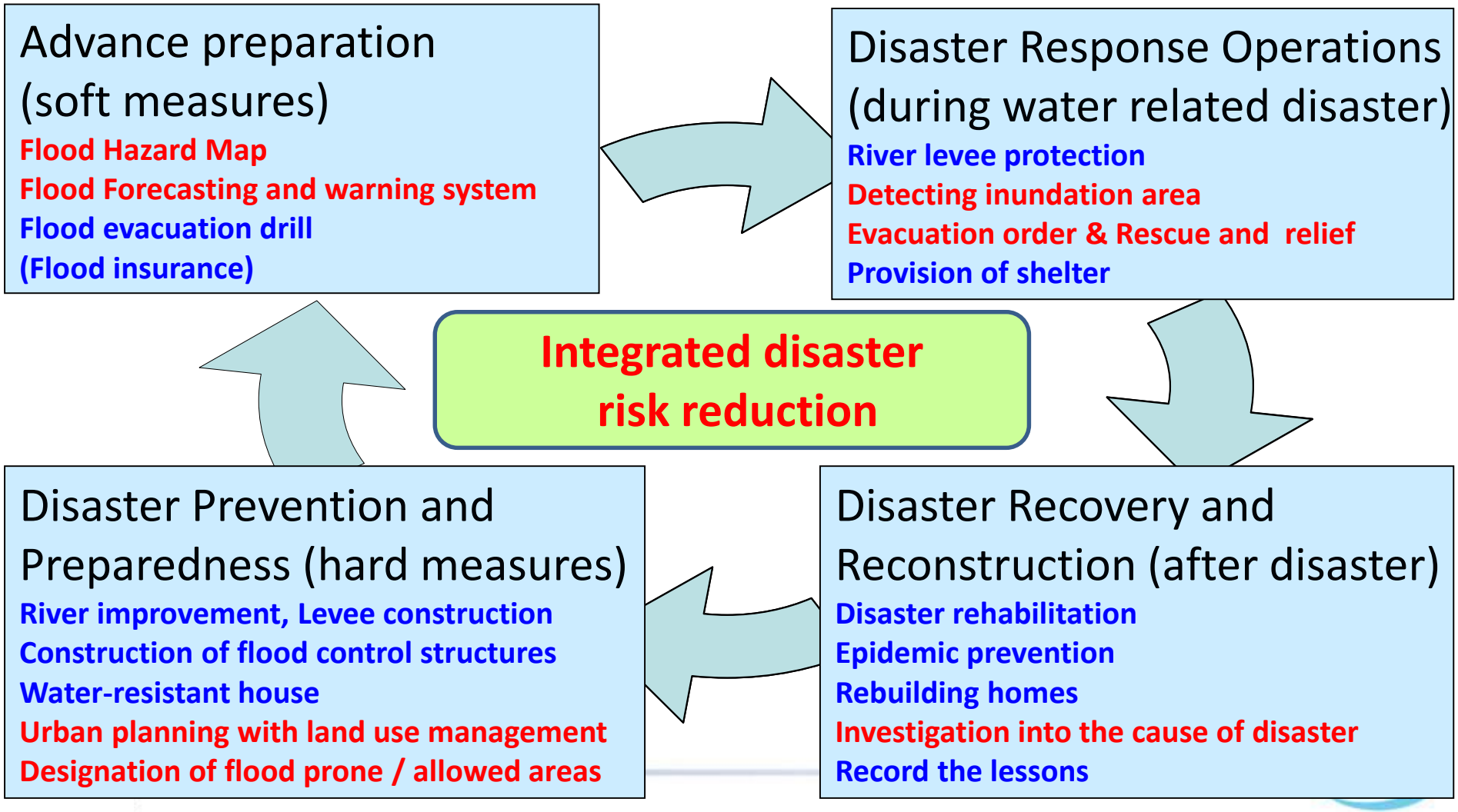
Water-related disasters WG

Function of the WG:

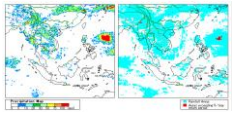
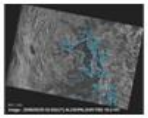
Voluntary based Research and Development activities and exchanging ideas with regard to water related disasters reduction by using aero-space technology together with ground survey and GIS/Mapping technology especially in the field of flood, land slide, flash flood, drought, storm surge and so on caused by heavy rain, typhoon, tropical cyclone, monsoon and climate change.

SA - STEP 3

Enhancing combined Use of Remote Sensing / GIS with Hydrologic / Hydraulic Simulation Technology contributes to All the Stages of Disaster Risk Management Cycle



Concept of Flood Monitoring in Sentinel Asia

	Observation		Processing		Integration
1) Rainfall Monitoring & Flood Forecasting	Rainfall Measurement from Satellites  TRMM, GPM, AMSR-E…	・Rainfall Data	Rainfall distribution Estimation Runoff/Inundation Analysis  GSMaP*1, GFAS*2, IFAS*3, RRI*4	・Precipitation Map ・Heavy Rainfall Estimation ・Flood Forecasting and Warning ・Probable Rainfall Map	Coupling with Global / In-situ Data on GIS - Social Economic Data - Land-use/cover Data  - Heavy Rainfall Alert - Real-time Flood Inundation Monitoring - Precipitation and Flood Inundation on Web GIS - Flood Alert for Specific River Basins - Flood Risk Map - Flood disaster damage map - Evacuation map
2) Flood Detection & Situation Analysis	Land Observation from Satellites  ALOS, MODIS, AMSR-E….	・Land Image	Fine DEM Generation Flooding Area Detection  JAXA, ICHARM, Dartmouth University…	・Identification of Flood-prone Area and Flooding Frequency • Flood Hazard Map	

Creating and Sharing Information for Flood Management In all Stages of Flood Disaster

Users

Residents in Flood-prone Area

・Planning
・Warning

・Evacuation
・Rescue
・Remediation

Disaster Management Organizations

*1 GSMaP = GSMaP_nRT
= Near Real-time Global Satellite-based Map of Precipitation (by JAXA)
*2 GFAS = GFAS-Rainfall
= Global Flood Alert System – Heavy Rainfall Alert (by IFNet)
*3 IFAS = Integrated Flood Analysis System
for the implementation of the concept of GFAS-Streamflow (by ICHARM)
*4 RRI = Rainfall-Runoff-Inundation model (by ICHARM)

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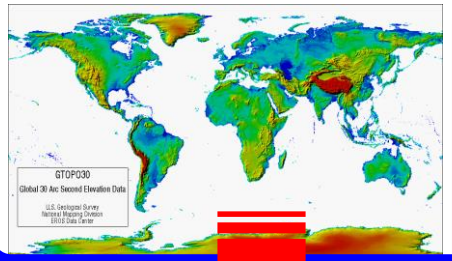
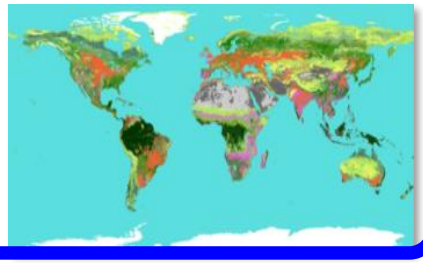
ICHARM activities

1) Rainfall monitoring and flood forecasting

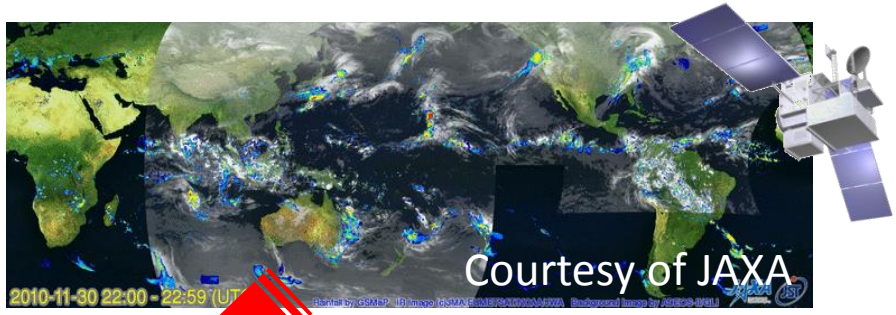
Integrated Flood Analysis System (IFAS)
Flood EWS for insufficient observed basin (free software)

Global data: topography, land use, soil data etc.





Satellite rainfall and ground-gauged data

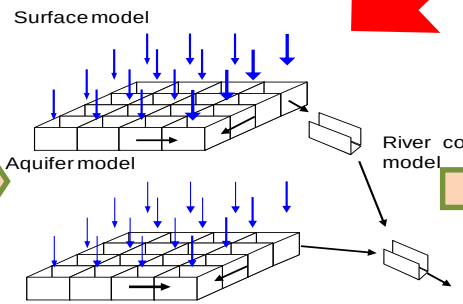


input

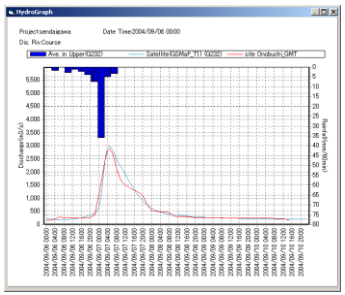
input

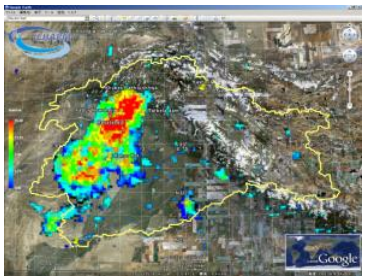
Run-off analysis by PWRI
distributed tank model

Model creation



Output: River discharge, Water level, Rainfall distribution





Evacuate from dangerous areas

Judge by River management authorities

Alert message by E-mail

and on the display for river management authorities

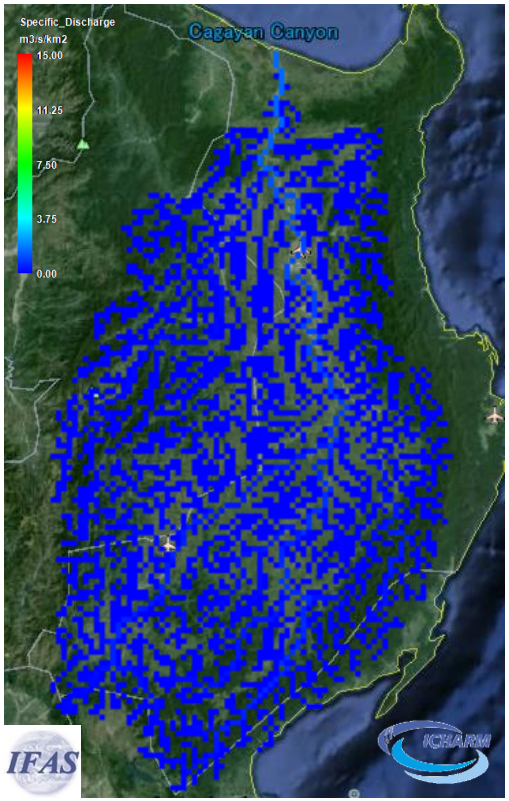
Discharge reaches warning level

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



Critical level: 0.76
Alarm level: 0.39
Alert level: 0.23

Specific discharge

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

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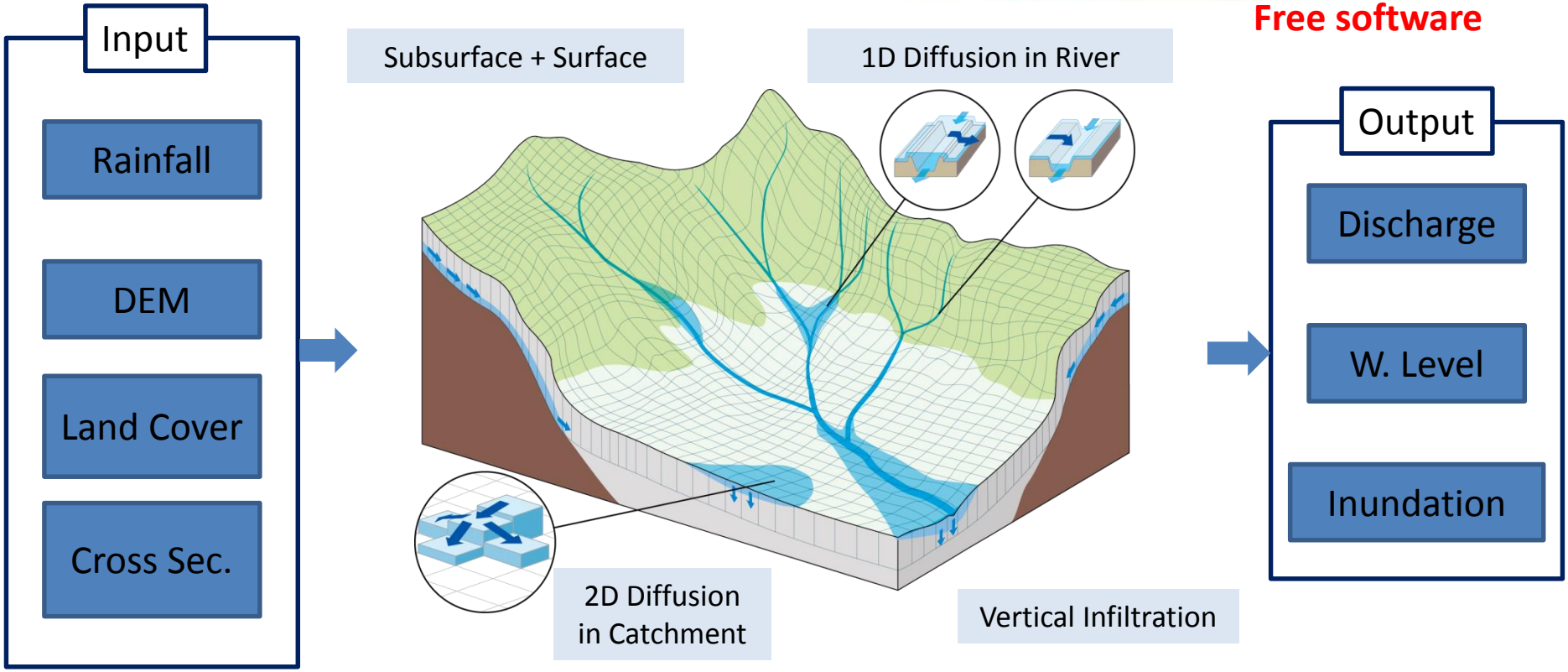
ICHARM RRI（Rainfall-Runoff-Inundation）Model

Free software



- 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.

Global Centre of Excellence for Water Hazard and Risk Management

ICHARM

International Centre for Water Hazard and Risk Management under the auspices of UNESCO

http://www.icharm.pwri.go.jp/index_j.html

Our Mission

The mission of ICHARM is to serve as the Global Centre of Excellence for Water Hazard and Risk Management by, inter alia, observing and analyzing natural and social phenomena, developing methodologies and tools, building capacities, creating knowledge networks, and disseminating lessons and information in order to help governments and all stakeholders manage risks of water-related hazards at global, national, and community levels.
(Revision on 25th February, 2014 (Partially citation))

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▸ 29 July 2016

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M Three Pillar Activities
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formation Network

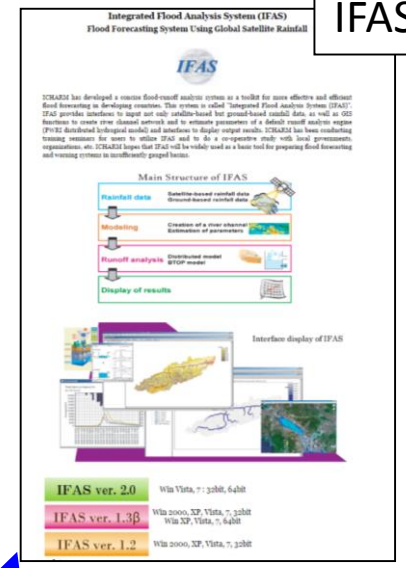
Local Practices

IFAS Integrated Flood Analysis System

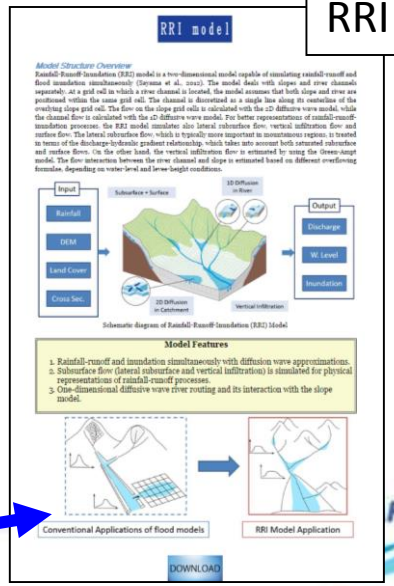
RRI model

Download page of IFAS ad RRI

IFAS



RRI



Application of IFAS and RRI

Flood forecasting system based on IFAS

- Indonesia/Solo river basin（ADB project, -2012）
- Philippines/Cagayan river basin（ADB project, -2014）
- Pakistan/Indus River basin（UNESCO project, -2014）
- Viet Nam/Thai Binh river basin (SAFE project)
- Malaysia/Kelantan & Dungun river basin (SATREPS pro.)

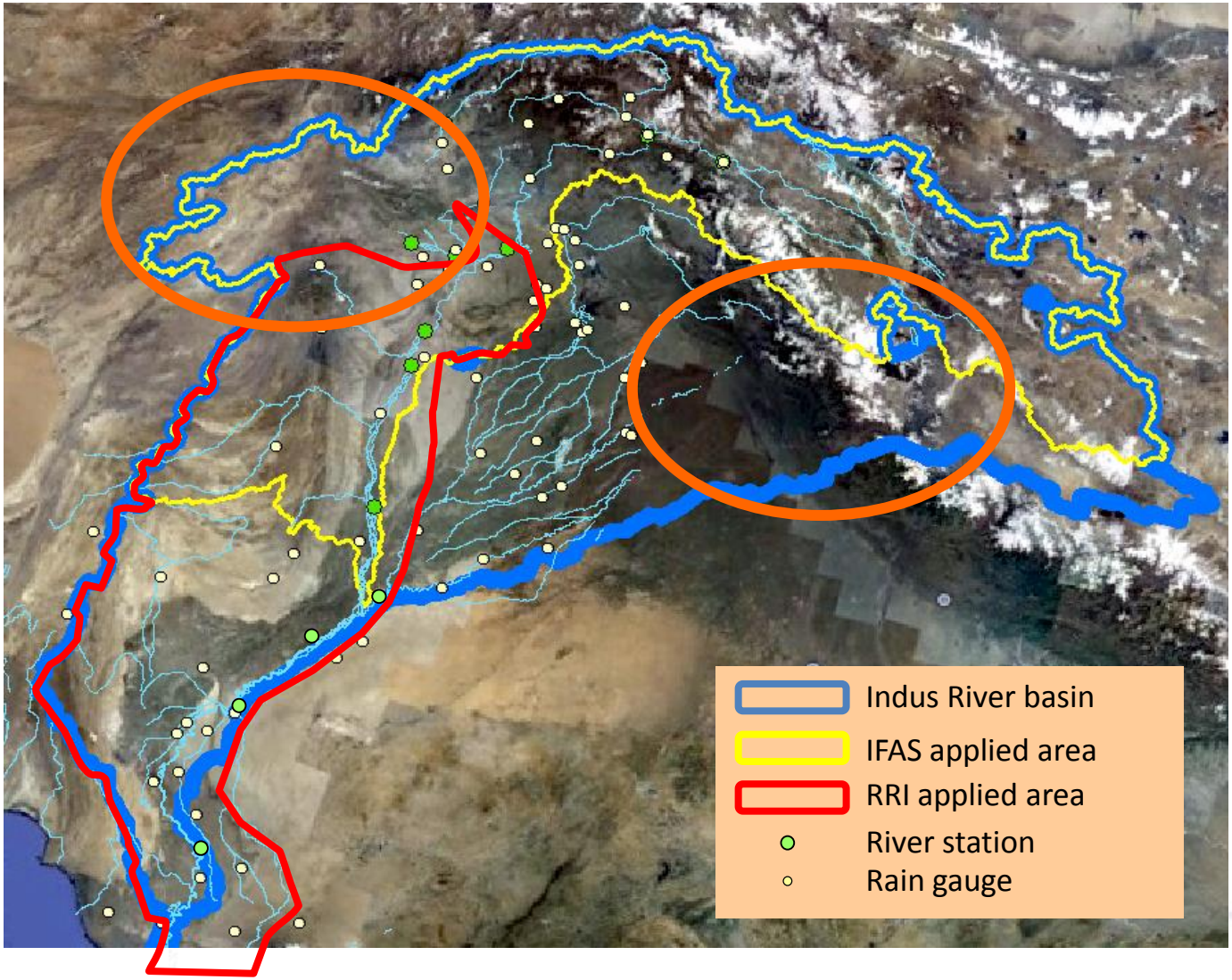
Flood forecasting system based on RRI

- Thailand/Chao Phraya river basin (JICA pro, 2013)
- Pakistan/Indus river basin（UNESCO project, -2014）
- Myanmar/Yangon plain etc.（ADB）
- Sri Lanka/Kalu river（JAXA, on going）

Indus River basin modeling

Indus-IFAS
- Upper basin → IFAS
- Middle and lower basin → RRI

Challenges for Indus River basin modeling



- Insufficient rain gauge network
- Difficulty of modeling snowmelt from high mountains (over EL.7000m)

Global Precipitation Measurement (GPM)

GPM satellite was launched on Feb. 27, 2014 as a succession of TRMM.

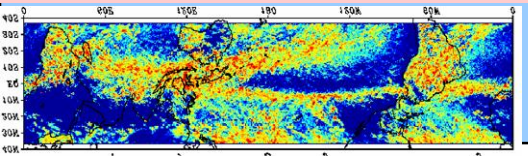
Core Satellite

Dual Frequency Radar
Multi Frequency Radiometer

✧Observation of rainfall with more accurate and higher resolution

✧Adjustment of data from constellation satellites

JAXA (Japan)
Dual frequency Radar, Rocket
NASA(US)
Satellite Bus, Micro-wave gauging measurement

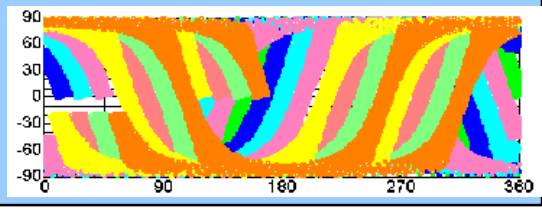


8 Constellation Satellites

Satellites with Micro-wave Radiometers

✧More frequent Observation

Cooperation：
NOAA(US),NASA(US),ESA(EU), China, Korea and others



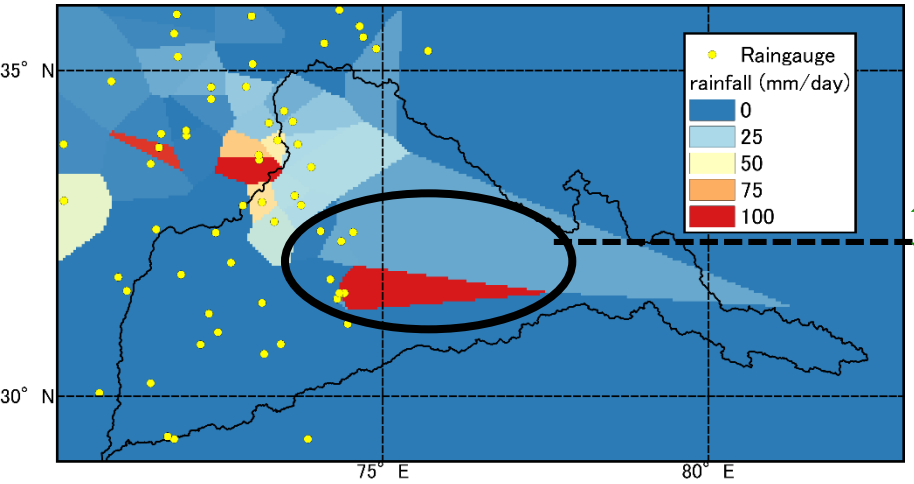
–Earth heating Phenomena
–Study of Climate Change
–Improvement of forecasting system

Global Observation every 3 hours

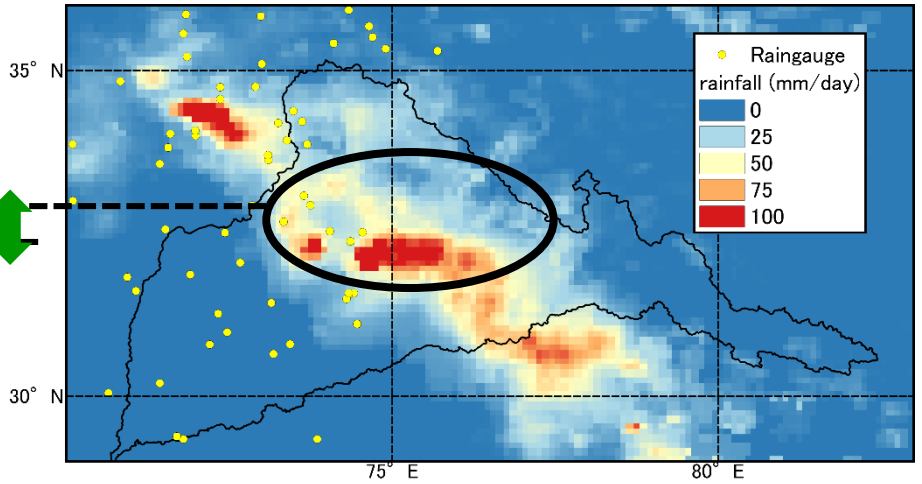
- IWRM
- Flood Forecasting
- Forecasting of crop productivity

Bias correction of GSMaP (GSMaP-IF2, July 16, 2015)

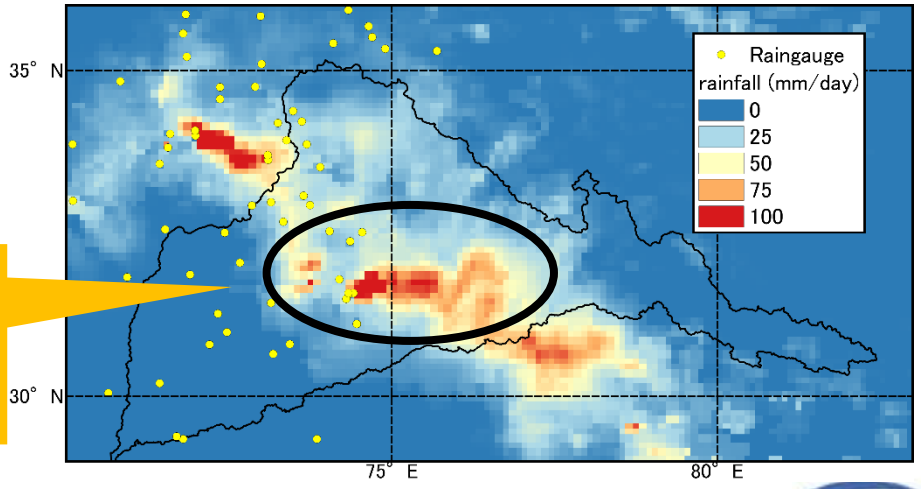
Ground (Thiessen)

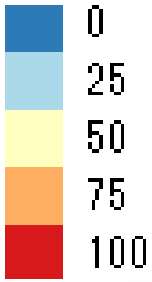


GSMaP_NRT



Corrected GSMaP (GSMaP_IF2)

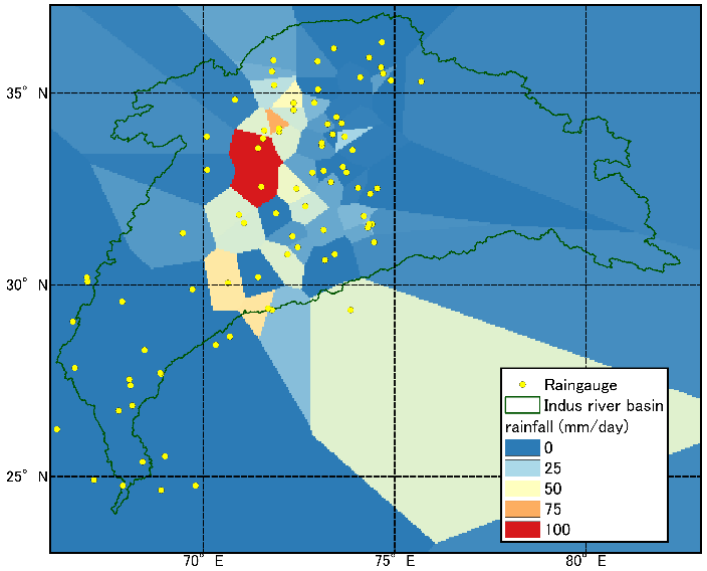




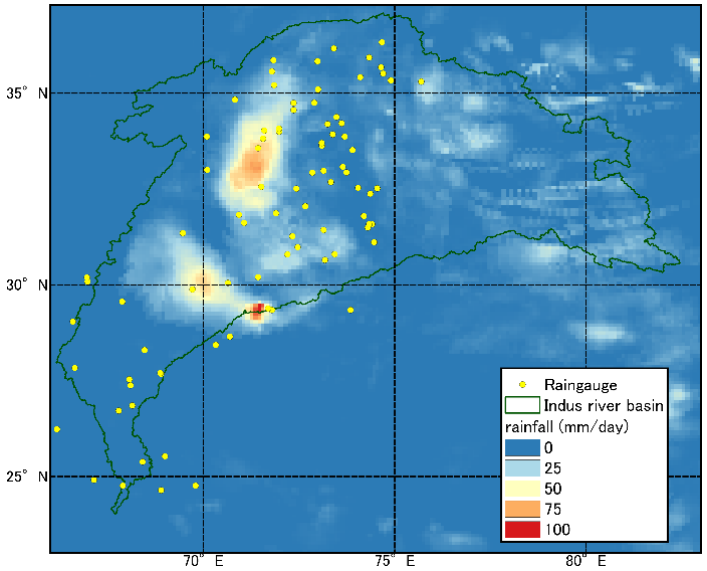
Geolocation error was corrected

Bias correction of GSMaP (GSMaP-IF2, July 16, 2015)

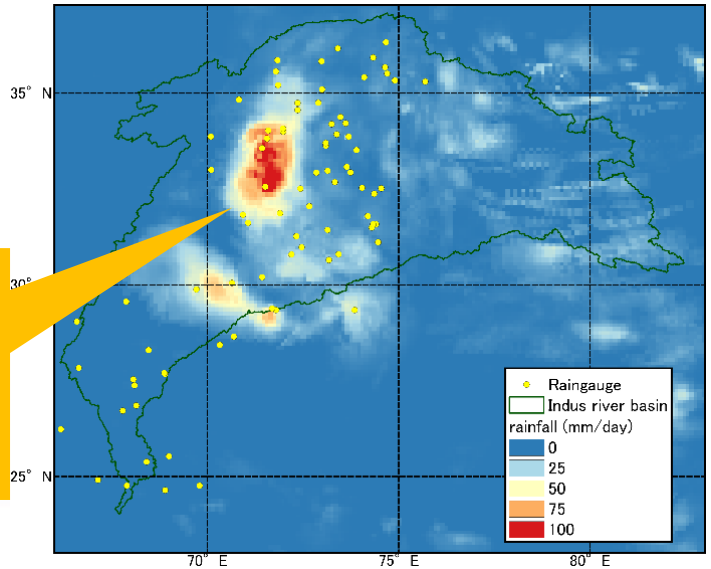
Ground (Thiessen)

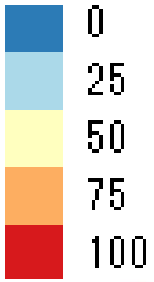


GSMaP_NRT



Corrected GSMaP (GSMaP_IF2)





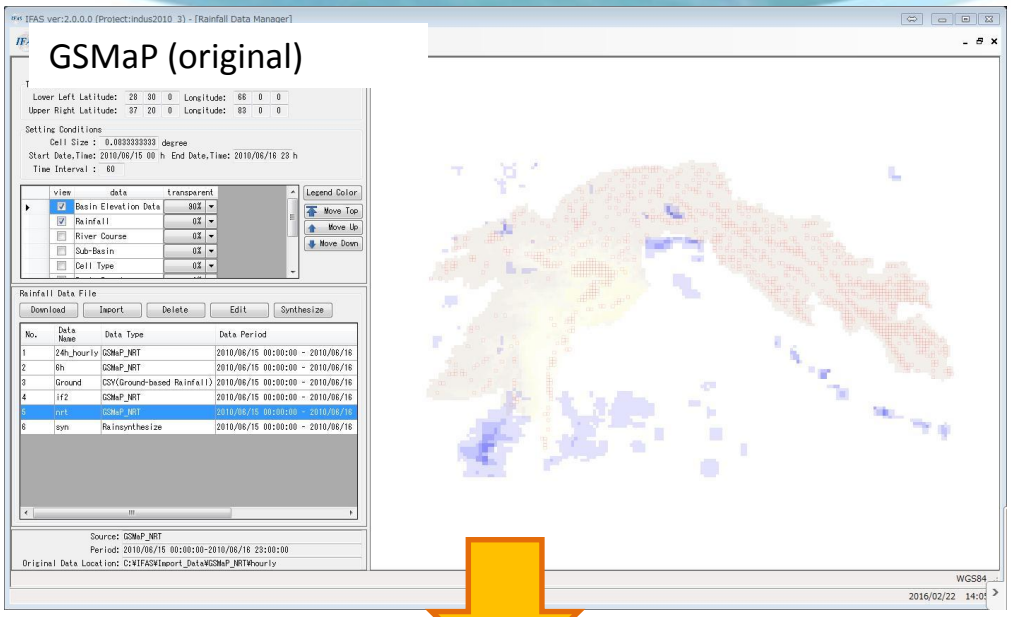
Rainfall intensity was improved as ground observation

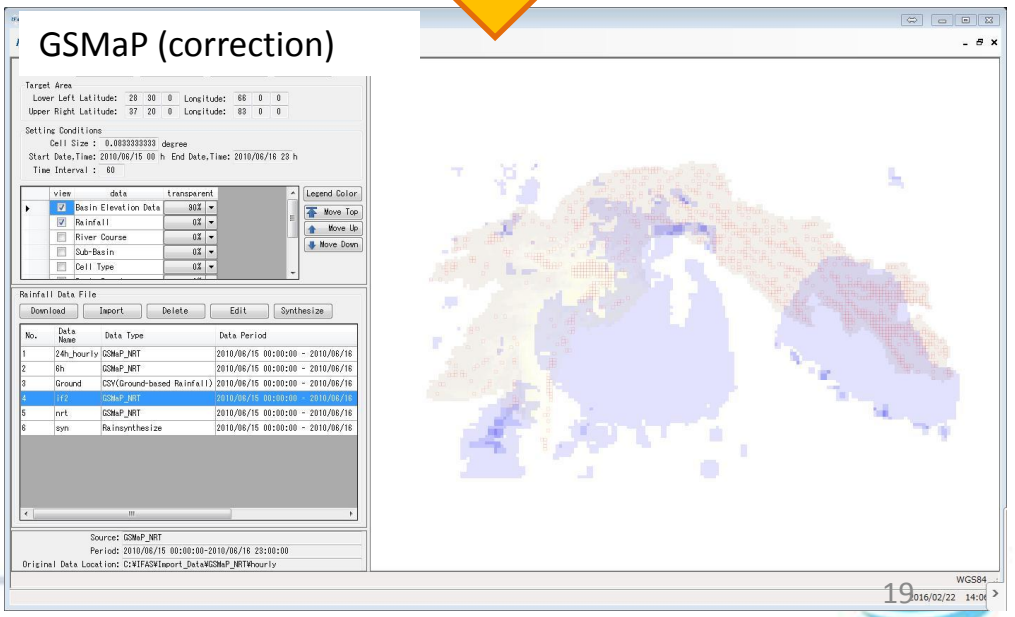
GSMaP-IF2 (JAXA-NTT data) on IFAS

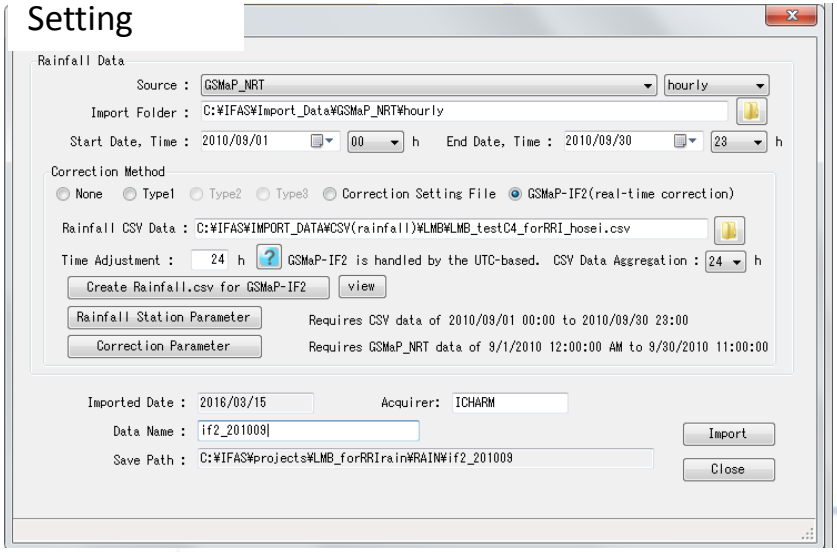
GSMap-IF2 and IFAS is connected on the interface of IFAS

Input:
IFAS format ground rainfall data is used directly

Output:
IFAS format imported rainfall data (asc format)







GSMaP-BC training in SAFE prototyping project

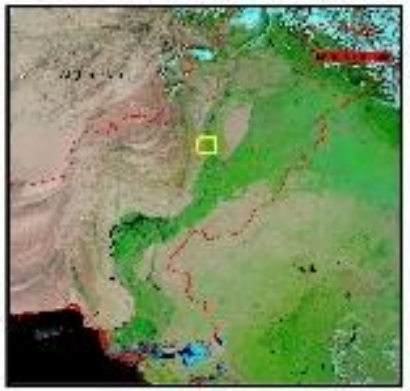
"Developing and Implementing an Operational Prototype for Advanced Flood Forecasting, Early Warning, and Data Sharing System in the Kalu Ganga Basin, **Sri Lanka**"

2016 August 22-24, GSMaP bias correction training, Sri Lanka irrigation department

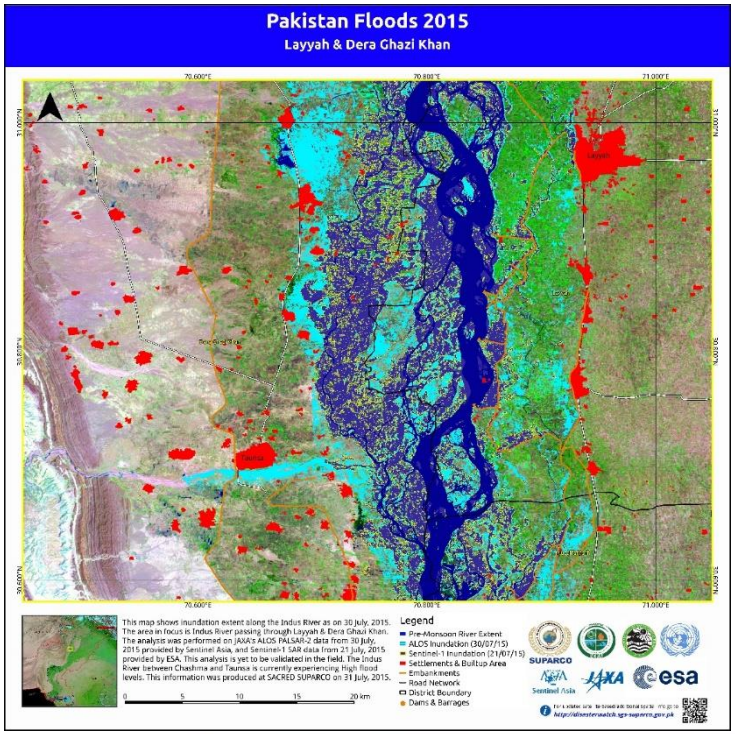
ICHARM activities

2) Flood detection and Situation analysis

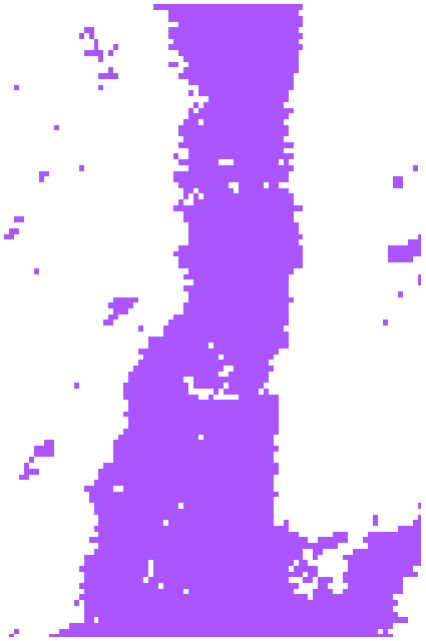
Verification of simulation result of RRI for 2015 flood



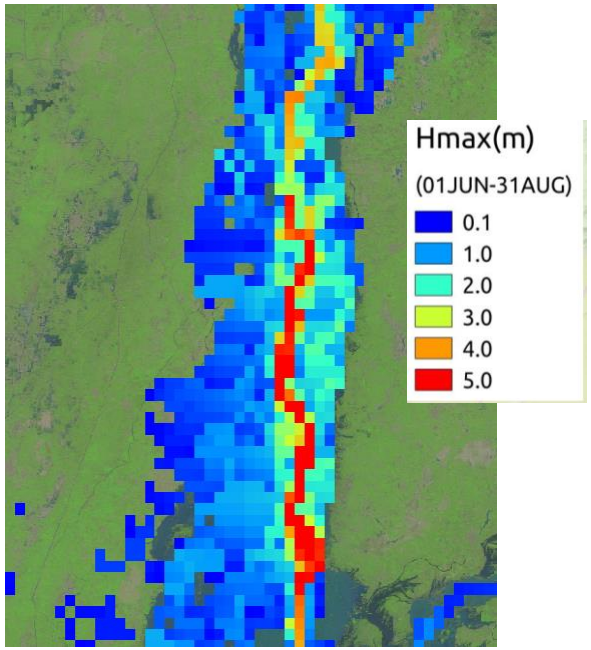
August 7, SUPARCO (SAR)



Modis
Maximum inundation area
(20150701-0831)



RRI (Maximum inundation depth
20150615-0930)



Multi-temporal flood change during the 2011 Chao Phraya River flood by using MODIS time-series images from 21 August to 24 November 2011

Modified Land surface water index

MLSWI can directly detect floodwaters from the reflectance of temporal MODIS during flood events

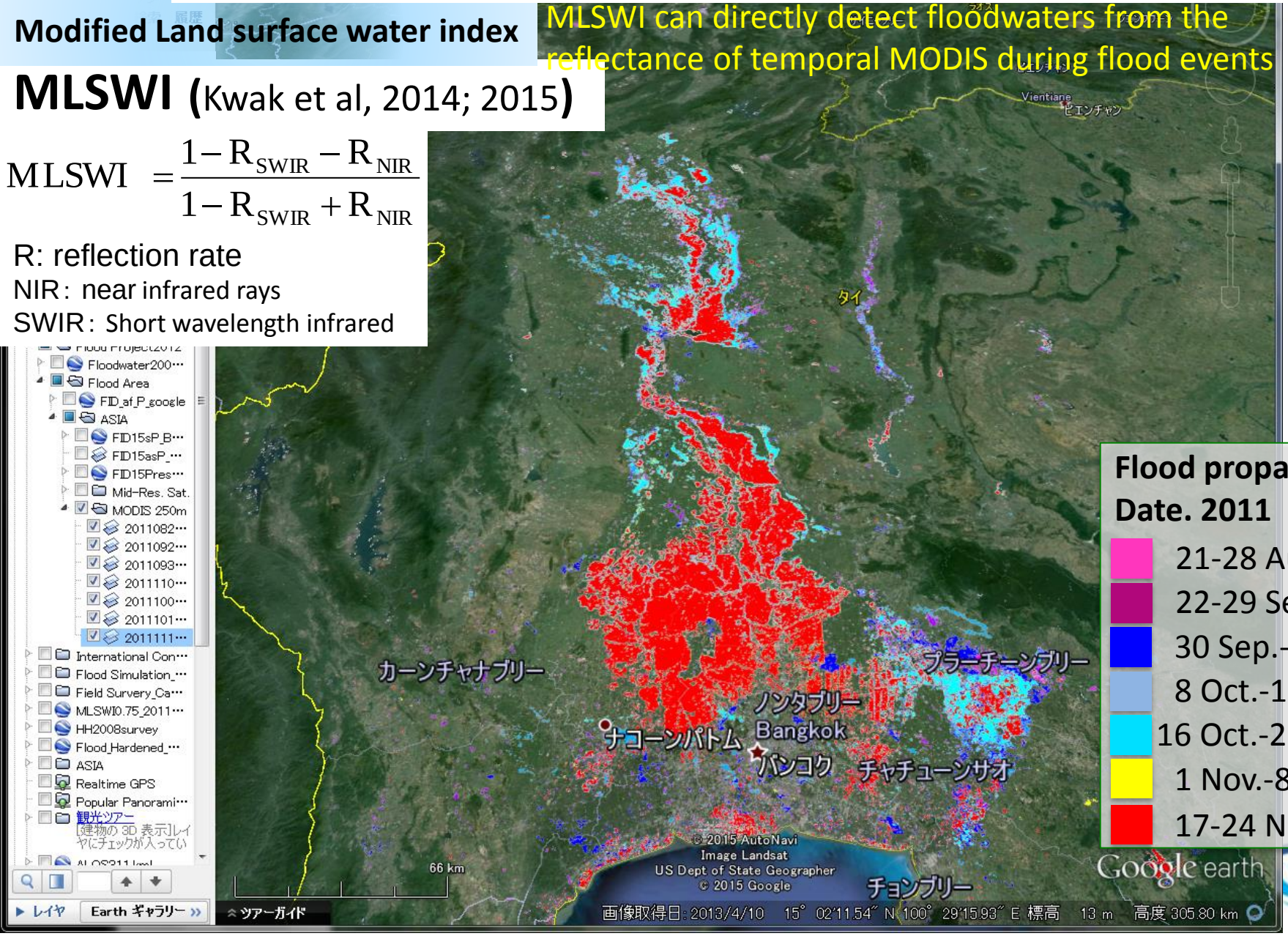
MLSWI (Kwak et al, 2014; 2015)

$$MLSWI = \frac{1 - R_{SWIR} - R_{NIR}}{1 - R_{SWIR} + R_{NIR}}$$

R: reflection rate

NIR: near infrared rays

SWIR: Short wavelength infrared



Flood propagation Date. 2011

- 21-28 Aug.
- 22-29 Sep.
- 30 Sep.-7 Oct.
- 8 Oct.-15 Oct.
- 16 Oct.-23 Oct.
- 1 Nov.-8 Nov.
- 17-24 Nov.

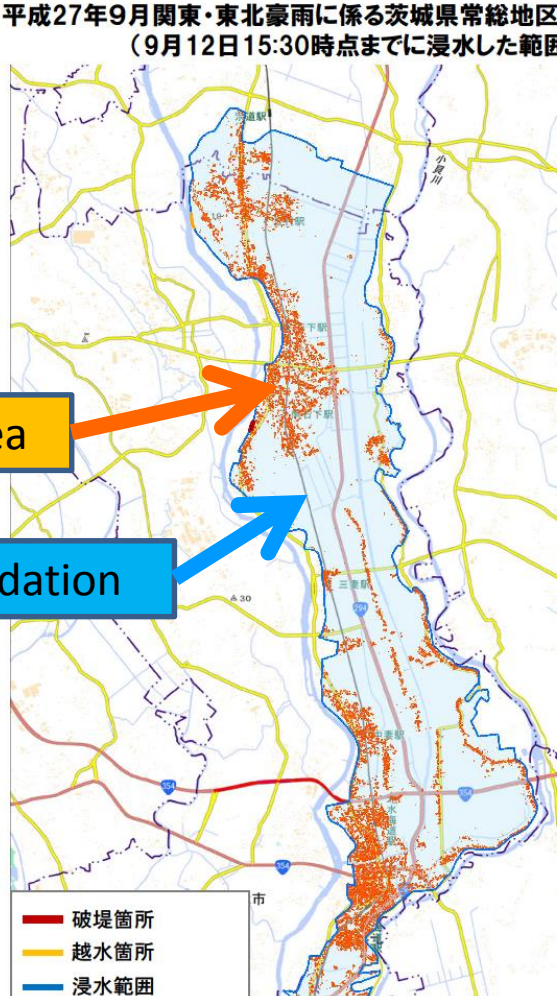
Synthetic Aperture Radar (SAR) in all weather

ALOS-2/PALSAR-2 backscatter coefficient

Kinu river levee break inundation

（Difference between Sep. 10 (before) and Aug. 13 (after), 2015） (Lee filter 3x3)

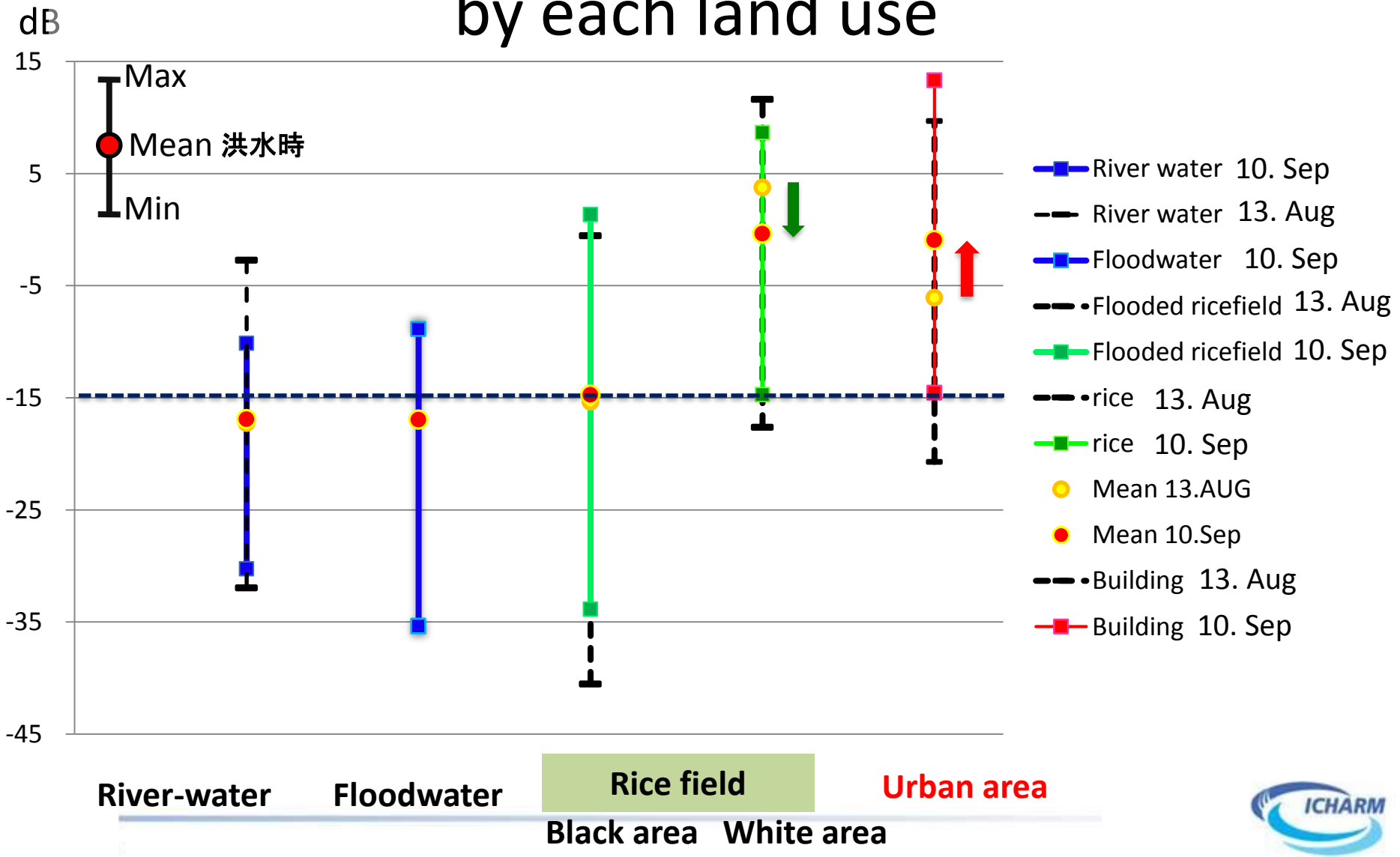
Pink area: Difference between the two points of time



housing area

inundation

Study of difference of back scatter coefficient between before and after flood by each land use

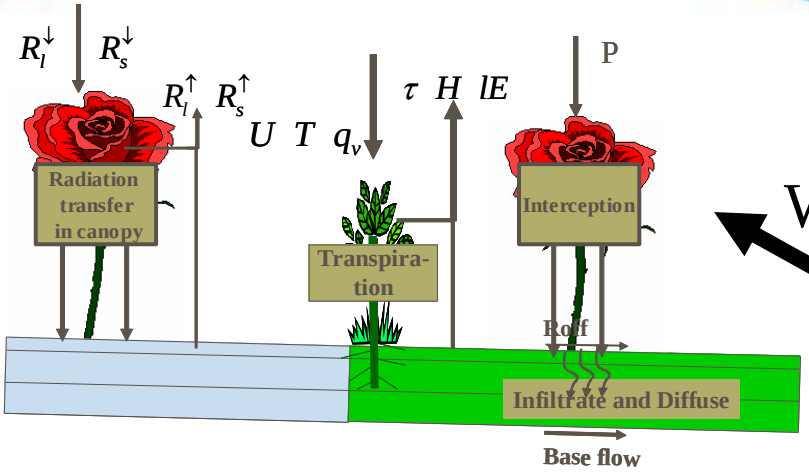


ICHARM activities

3) Data assimilation by satellite observation

Land Surface Model

LDAS-UT



Wsfc

Min: cost function
$F(Tb_{obs}-Tb_{sim})$

SiB2

Tb_{obs}

Tb_{sim}

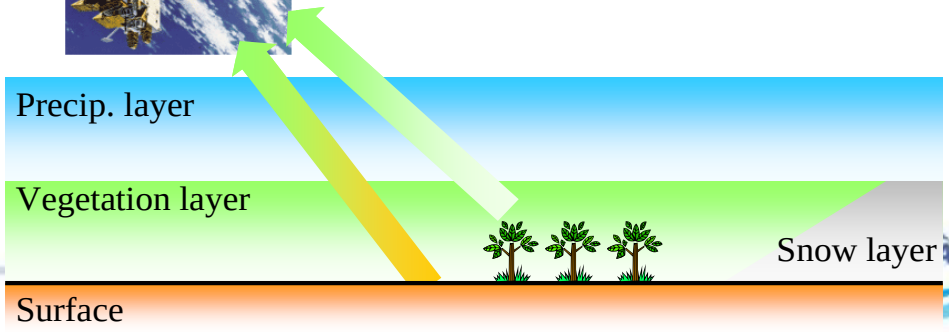
Tg, Tc, Wsfc

$$T_{bp} = T_g(1-\Gamma_p)\exp(-\tau_c) + T_c(1-\omega)[1-\exp(-\tau_c)][1+\Gamma_p\exp(-\tau_c)],$$

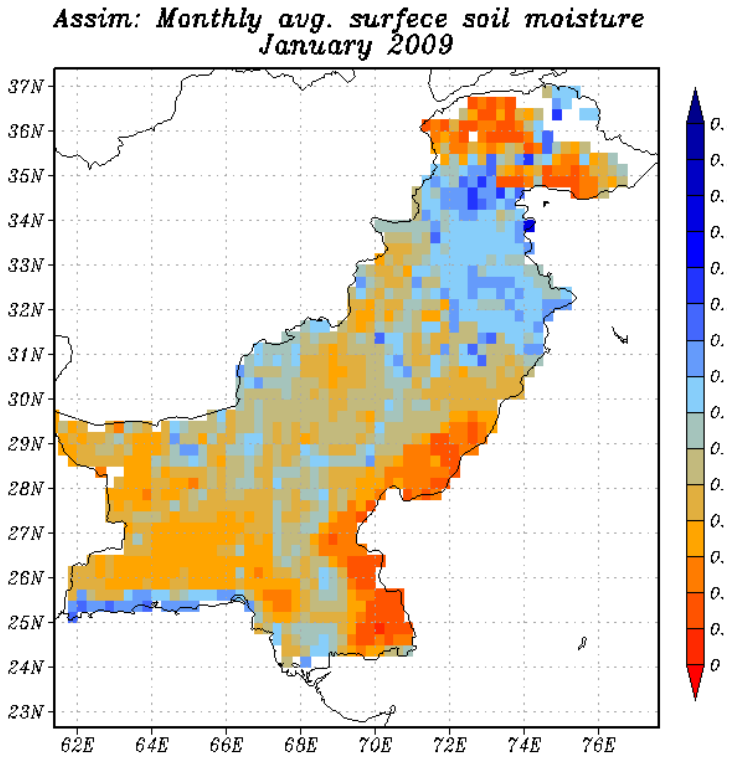
Surface radiation

Vegetation emission

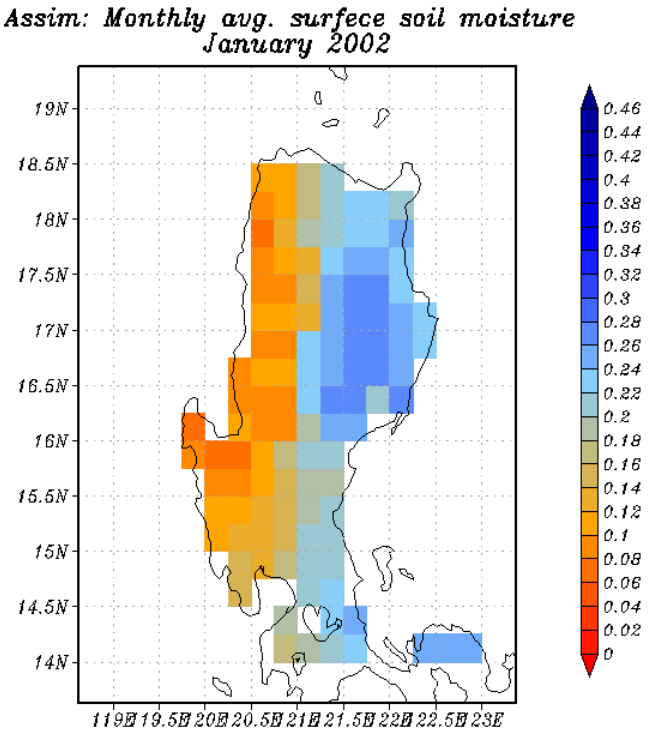
Radiative Transfer Model



Surface Soil Moisture



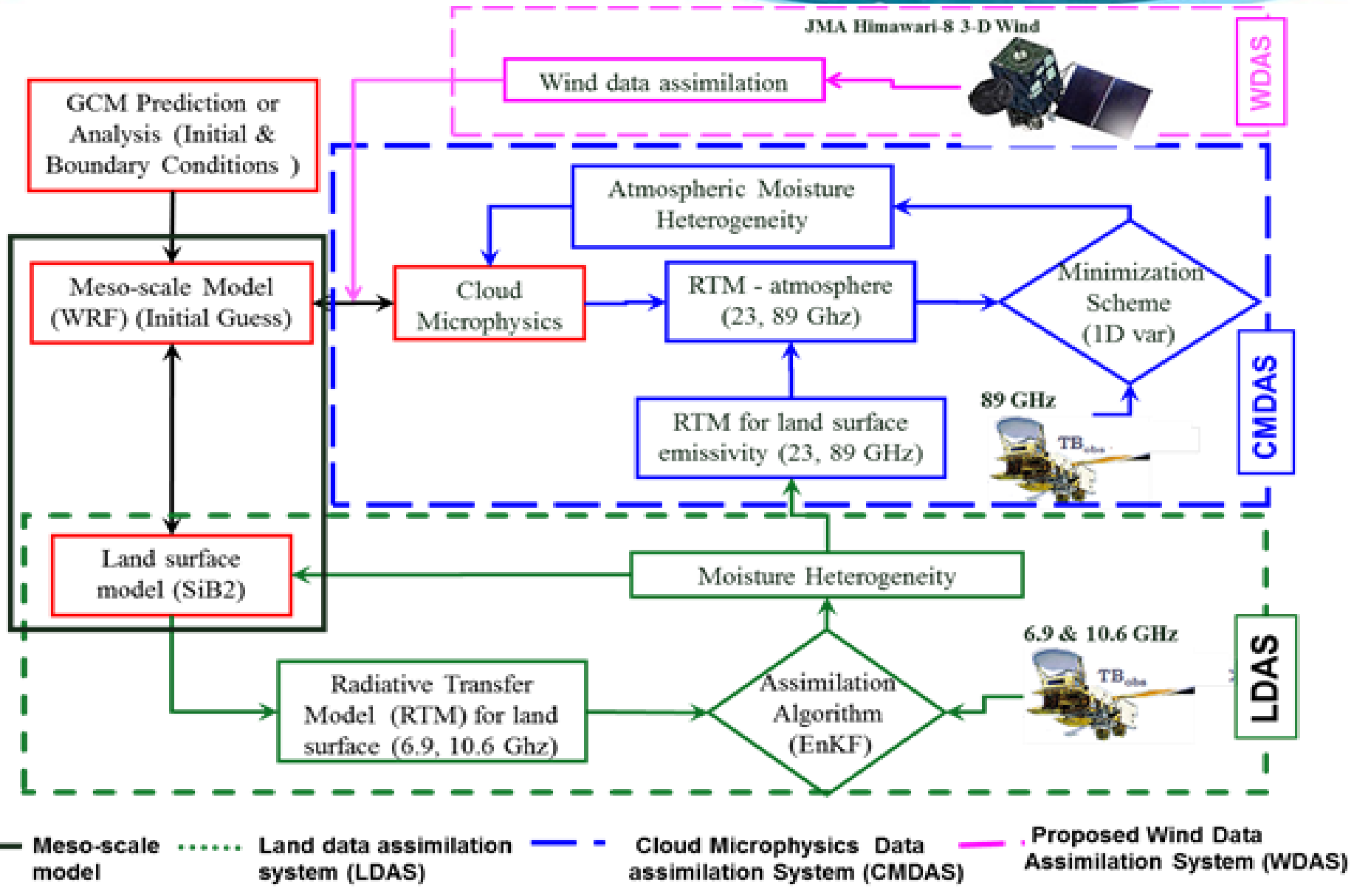
Pakistan



Philippines

NWP – Numerical Weather Prediction LSM – Land Surface Modeling

Weather Forecasting for improved Early Warning: CALDAS



ICHARM activities

4) Climate Change analysis

Comparison of Inundation Area and Rice Crop Damage under Present/future Climate

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

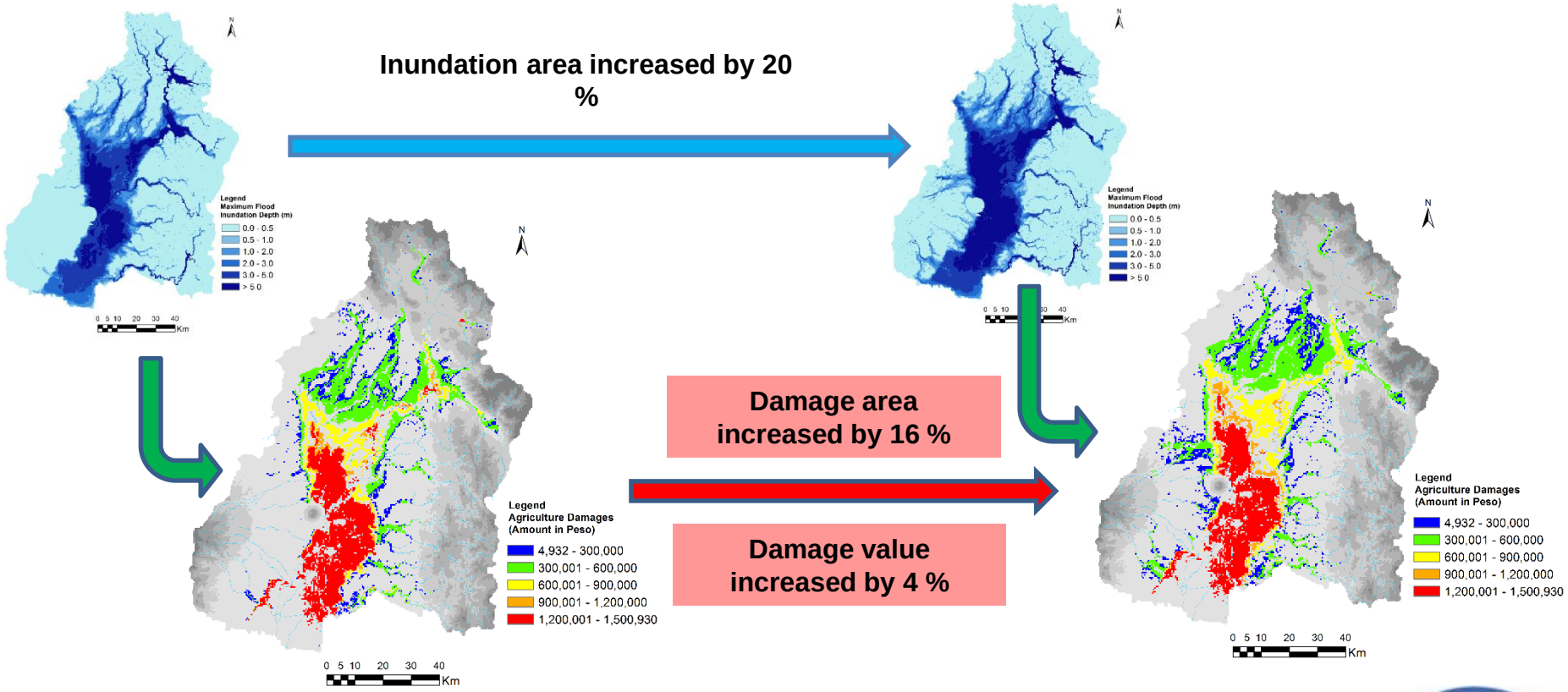
Present Climate: MRI AGCM3.2S SPA-AMIP

100-year Flood

Future Climate: MRI AGCM3.2S SFA rcp8.5

Inundation Area (>50 cm depth)= 3,661.2 km2

Inundation Area (>50 cm depth)= 4,376.6 km2



Damage area= 209,790 ha
Estimated Damage= 8,412.1 million Peso

Damage area= 243,101.25 ha
Estimated Damage= 8,756.7 million Peso

Climate change

Space technology for long term global monitoring and analysis is useful for climate change verification.

ICHARM activities

5) IFI (International Flood Initiative) activities

International Flood Initiative(IFI)

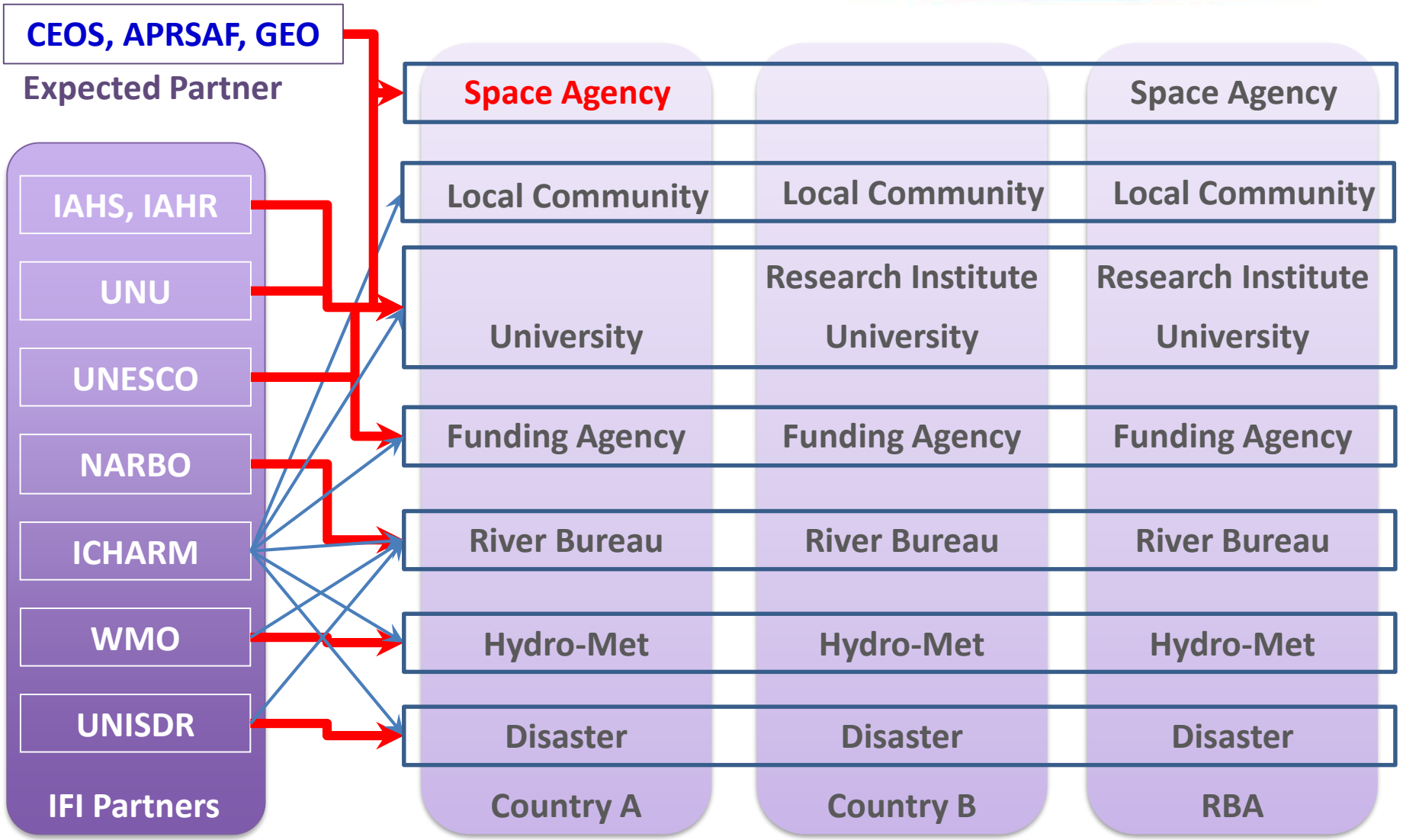
ICHARM is the secretariat of IFI.

International Flood Initiative (IFI) is a joint initiative in collaboration with UNESCO (IHP), WMO, UN/ISDR, UNU, IAHS and IAHR.

IFI launched in Jan. 2005 at the World Conference on Disaster Reduction in Kobe, Japan.

IFI is promoting to establish a multi stakeholders national platform for disaster risk reduction in accordance with Sendai framework, UN-SDGs and Paris agreement.

A multi stakeholders national platform



UN General Assembly adopted (December 20th, 2016)

International Decade for Action, "Water for Sustainable Development" 2018-2028

- ***Decides*** **that the objectives of the Decade should be a greater focus on the sustainable development and integrated management of water resources…**

Summary

- Satellite rainfall data (GAMaP) are available to observe rainfall distribution for operational near real time flood forecasting by making bias correction with in-situ data.
- Optical and SAR satellite data are useful to detect wide flood inundation area. Concentrated SAR observation is useful regardless of weather or night, however there are some challenges to identify flood area in the urban area.
- Satellite data have a lot of potential to use for data assimilation with simulation model.
- Monitoring for climate change by global satellite observation system is expected.
- Using space technology is highly expected for worldwide initiatives for disaster risk reduction.


Thank you for attention