Sentinel Asia Flood WG

- Report on Recent Activities
and Directions for Step 3 -

Yoichi IWAMI

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

1st JPTM for Sentinel Asia STEP 3

November 27-29, 2013, Bangkok, Thailand

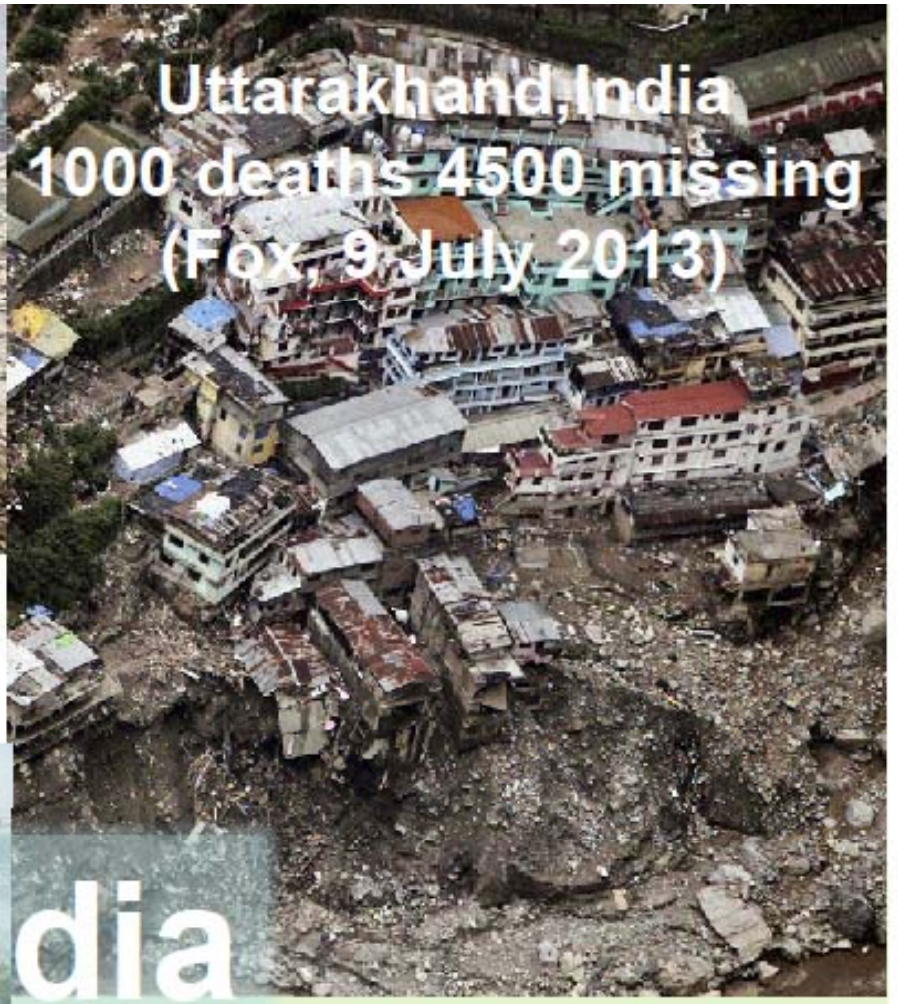
Indus Flood, Pakistan, July-Sep 2010
Deaths 1,985 Affected 20,185,000

<8 Aug 2010, BBC>

Landslide in Zhouqu, Gansu, China 2010. Photograph: AFP/Getty Images <The Guardian 11 Aug 2010>


Chao Phraya Flood, Thailand, Aug-Nov 2011
815 deaths, 3.6 million affected. <DPMD, MI>
US$ 43 B lost. <Munich Re>
BKK 2011.11.14
Rojana 2011.11.13
BKK 2011.11.13
Rojana 2011.11.13
2011 Thailand

The Mandakini river, Kedarnath, Uttarakhand, India (The New Indian Express, 18 June 2013)



Shrinagar, Uttarakhand (ZeeNews, India, 29 June 2013)

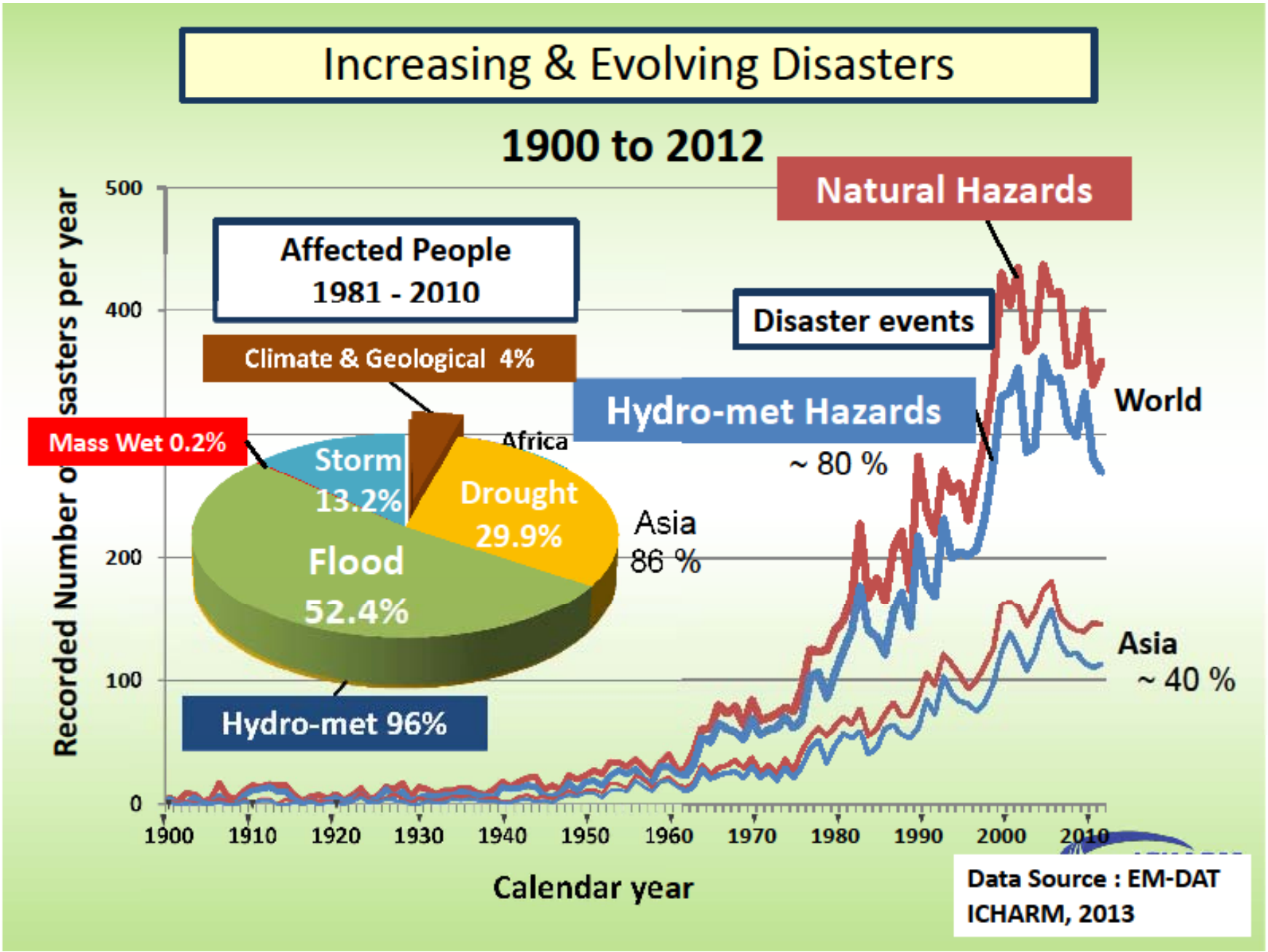
Shrinagar, Uttarakhand (India Today, 23 June 2013)

ICHARM

2013 Philippines

The International Charter (UNOSAT)
http://www.disasterscharter.org/web/charter/activation_details?p_r_p_1415474252_assetId=ACT-466

Destruction in Dulag Town, Leyte Province by Typhoon Haiyan


Increasing & Evolving Disasters
1900 to 2012
Natural Hazards
Affected People
1981 - 2010
Disaster events
Climate & Geological 4%
Hydro-met Hazards
~ 80 %
World
Mass Wet 0.2%
Africa
Storm
13.2%
Drought
29.9%
Asia
86 %
Flood
52.4%
Asia
~ 40 %
Hydro-met 96%
Recorded Number of Disasters per year
500
400
200
100
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Calendar year
Data Source : EM-DAT
ICHARM, 2013

Objective of Flood WG in Sentinel Asia (Step 1 & 2)

- To contribute to the mitigation of flood disasters in Asia through:
  - utilizing satellite, GIS and information network technologies, combined with in-situ data,
  - enhancing the development of the basis for sharing information on flood risks and disasters among national and international organization in relation to flood management,
  - and realizing the above development and information sharing on the basis of Sentinel Asia network system

Outcome of Flood WG (STEP 1, FY2006-2007)

- *Emergency ALOS-image delivery for flood disaster monitoring through the ADRC gateway* - supported by JAXA-ADRC
- *Global cloud cover image and its overlay on Digital Asia*
  - Provided by Japan Meteorological Agency (JMA)
- *Global satellite-based daily rainfall map & heavy rainfall identification and its overlay on Digital Asia*
  - Provided by IFNet (International Flood Network)
    = "GFAS" (Global Flood Alert System) based on NASA-3B42RT
- *Global flood identification using AMSR-E*
  - Linked with Dartmouth Flood Observatory
    = "Satellite Water Watch" on the basis of AMSR-E
- *Mini-projects for flood disaster management using satellitte and GIS databases*
  - Conducted by JAXA and AIT

Those are most fundamental data for flood management.

Outcome of Flood WG (STEP 2, FY2008-2012)

1. Enhancement of rainfall information

1) Global satellite-based hourly/10km-grid rainfall mapping based on microwave radiometers = GSMaP_nRT (JAXA)

2. Enhancement of flood / inundation forecasting system

1) **IFAS (Integrated Flood Analysis System)** applications with satellite-based / ground gauged rainfall and global GIS (ICHARM)

- APRSAF-IFAS Seminars = 1st: Myanmar (2010), 2nd: India (2011)
- MAHASRI-IFAS Seminar = Vietnam (2011)
- UNESCO-IFAS Seminar = 1st: Vietnam (2012), 2nd: Indonesia (plan)
- IFAS-based flood warning system = Bengawan Solo River (Indonesia / ADB), Indus River (Pakistan / UNESCO), Kelantan & Dungun Rivers (Malaysia / JICA-JST), 732 trainees from 43 countries until 2012

2) **RRI (Rainfall-Runoff-Inundation)** model applications with satellite-based DEM and global GIS (ICHARM)

- Chao Phraya River Flood in 2011 Mapping and Forecasting
- RRI-based flooding simulation system = Thailand, Philippines

GFAS(Global Flood Alert System) - Rainfall

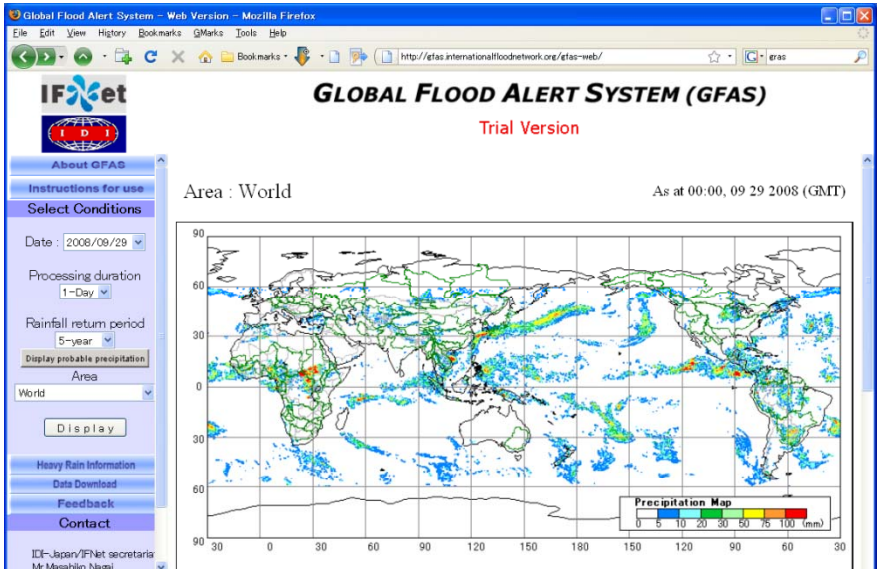
http://gfas.internationalfloodnetwork.org/gfas-web/

Rainfall information
from observation satellites

Data Obtainment
Data Processing
Data Dissemination

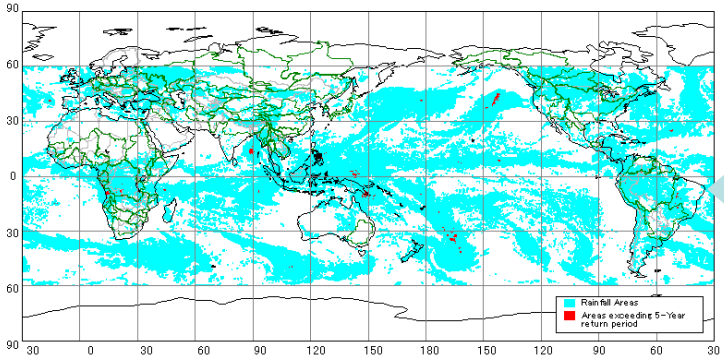
Website: Maps, Data
E-mail delivery:
Heavy Rain Notice

Flood Forecasting and Warning
by using GFAS information



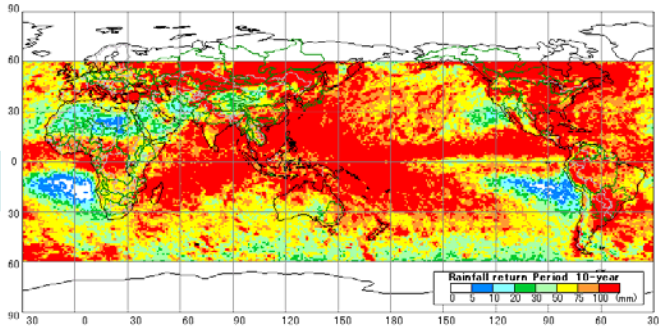
Real-time Rainfall Map (every 3 hour)

Heavy rainfall identification → alert



Real-time estimation of rainfall areas

Exceeding 10- (or 5-) Year Return Period

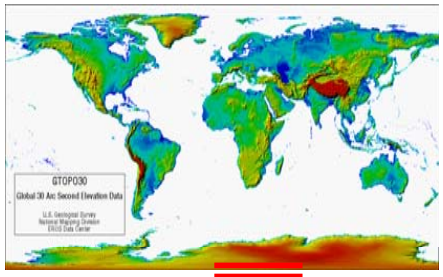


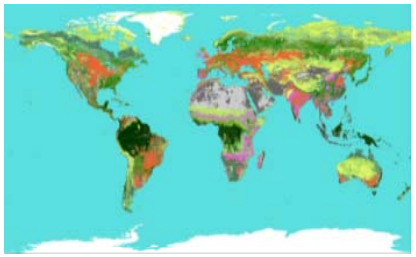
Pre-analyzed rainfall distribution exceeding 5 or 10-year return period

Integrated Flood Analysis System (IFAS)

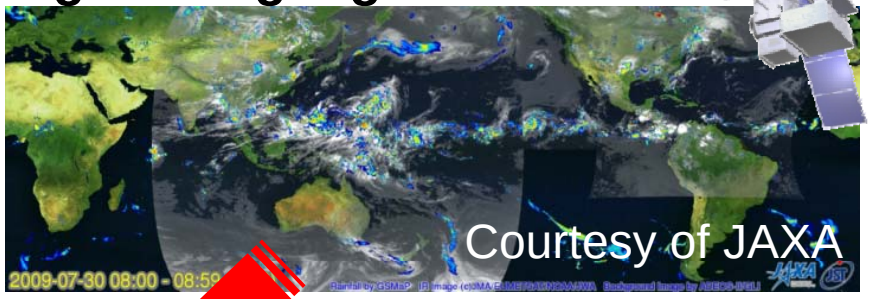
GFAS – Stream flow", basin by basin

Global data: topography, soils, land use and so on





Import satellite rainfall / ground-gauged data



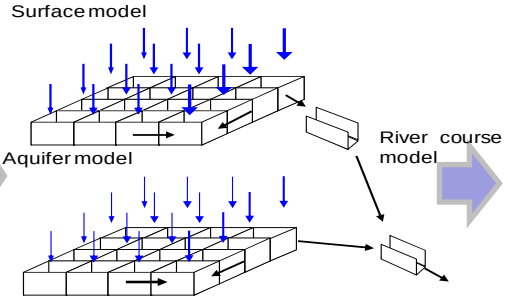
input

input

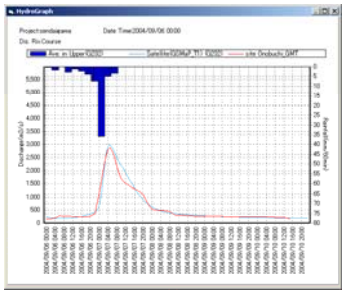
Run-off analysis by PWRI distributed tank model

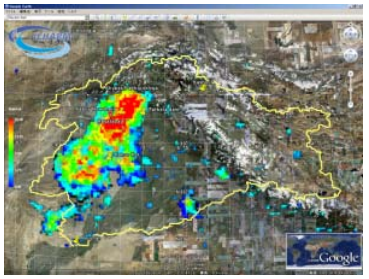
Model creation

IFAS



Output: River discharge, Water level, Rainfall distribution





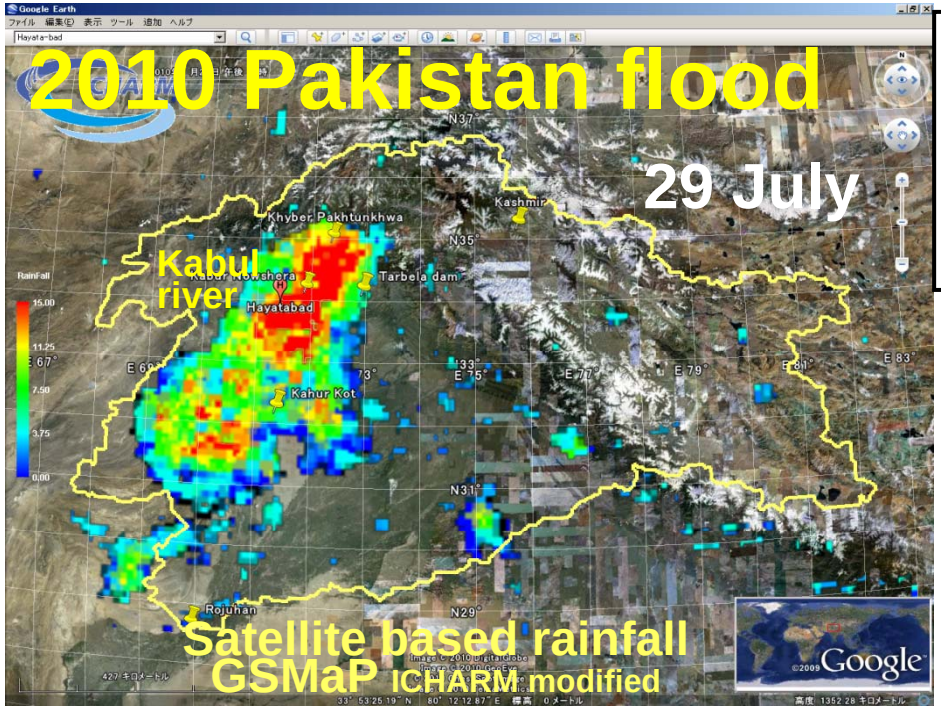
Discharge reaches warning level

Alert message by E-mail

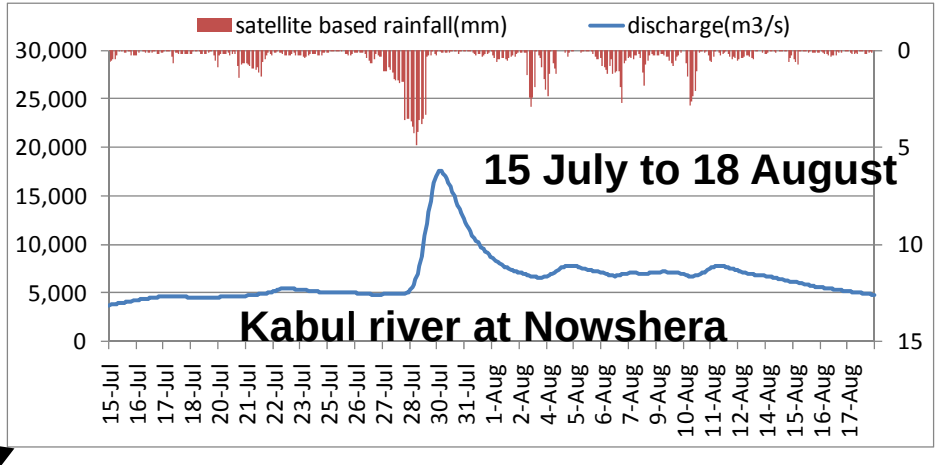
and on the display for river management authorities

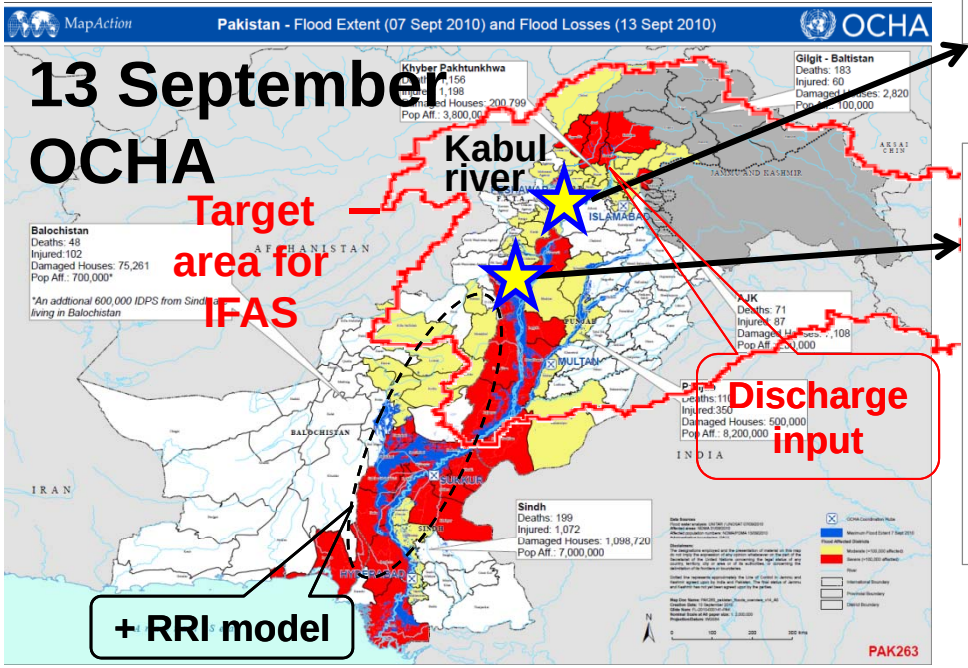
Judge by River management authorities

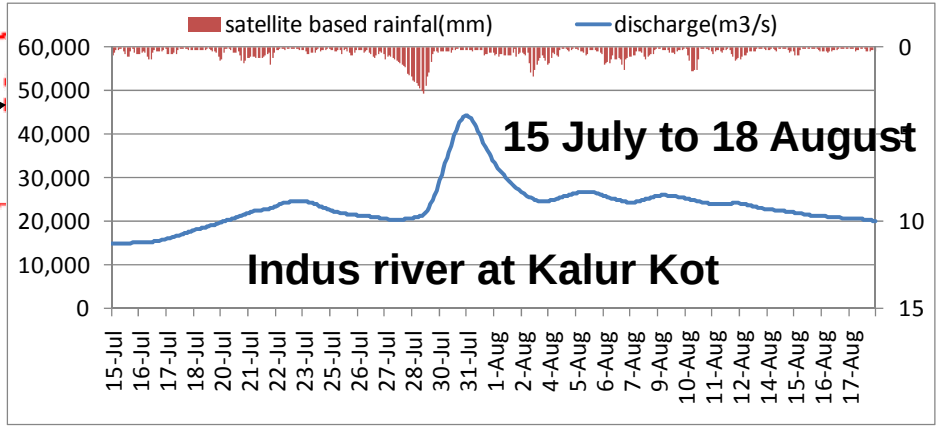
Evacuate from dangerous areas



UNESCO Project (2 years: 2012-14)
Strategic Strengthening of Flood Warning and Management Capacity of Pakistan

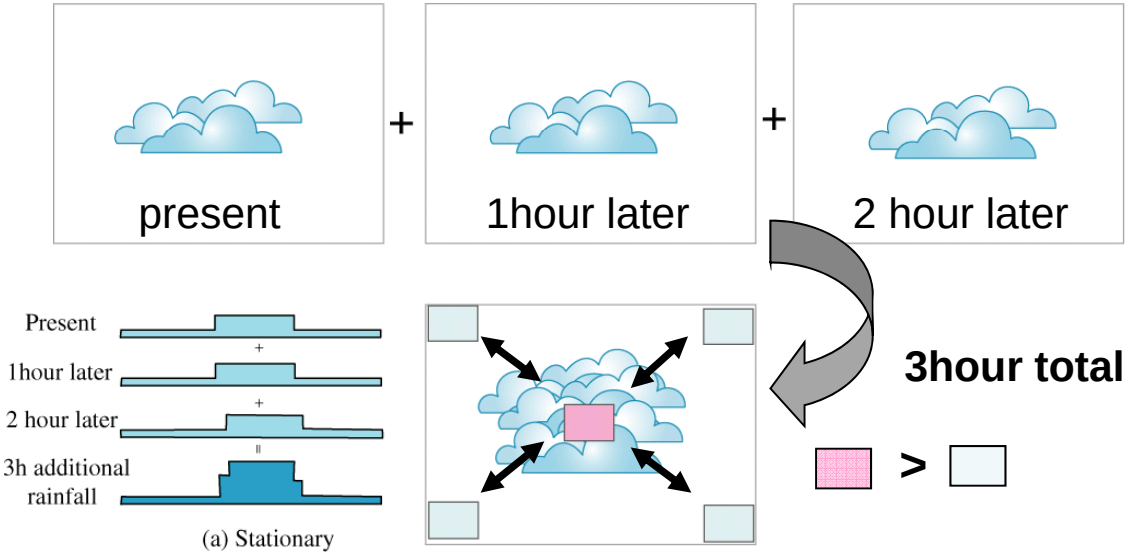




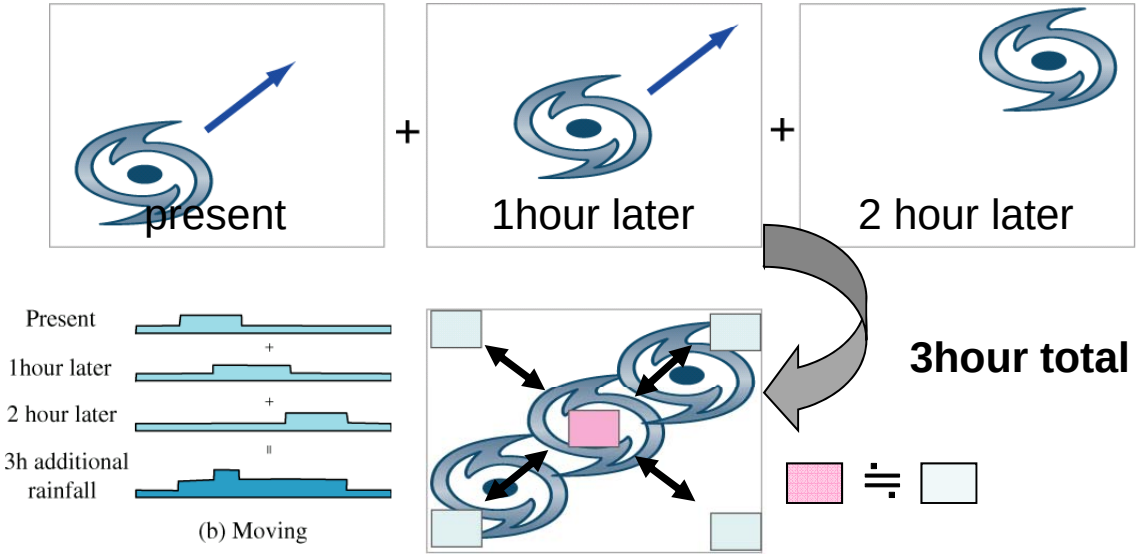


Algorithm for self-correction of satellite-based rainfall data by ICHARM

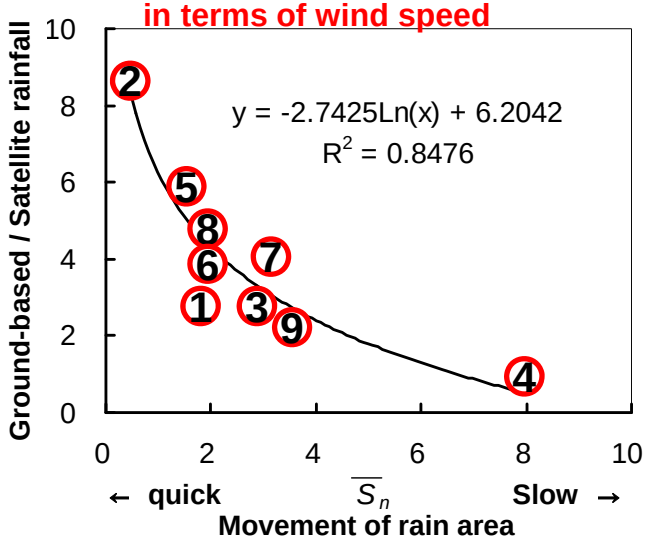
Rain event with slow movement of a rainy area

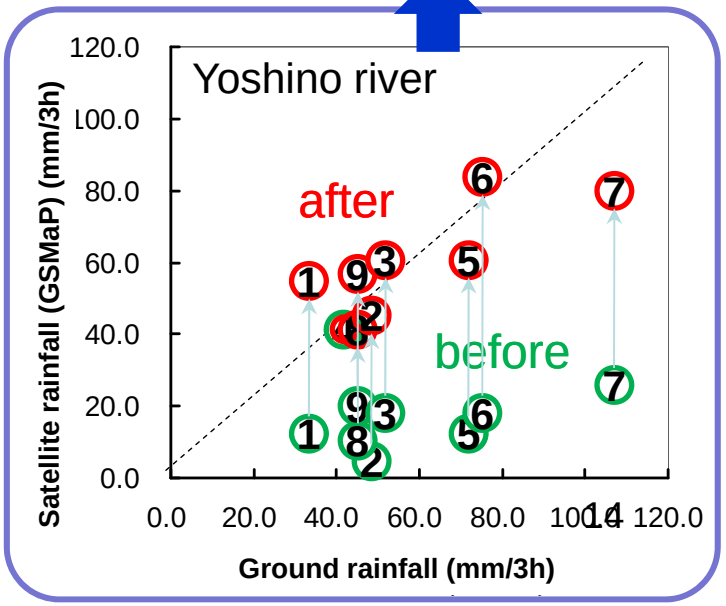


Rain event with quick movement of a rainy area



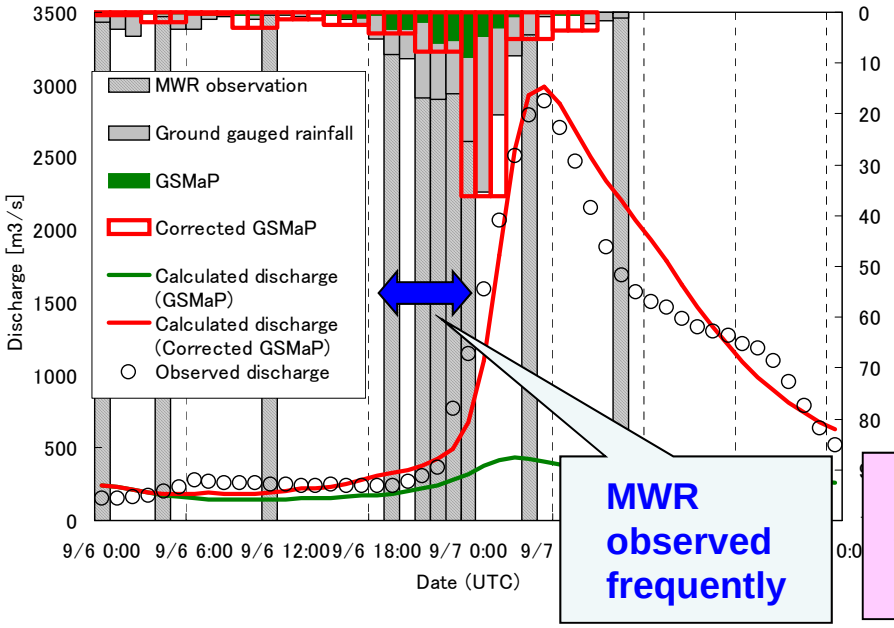
correction method to describe the difference of rainfall events in terms of wind speed



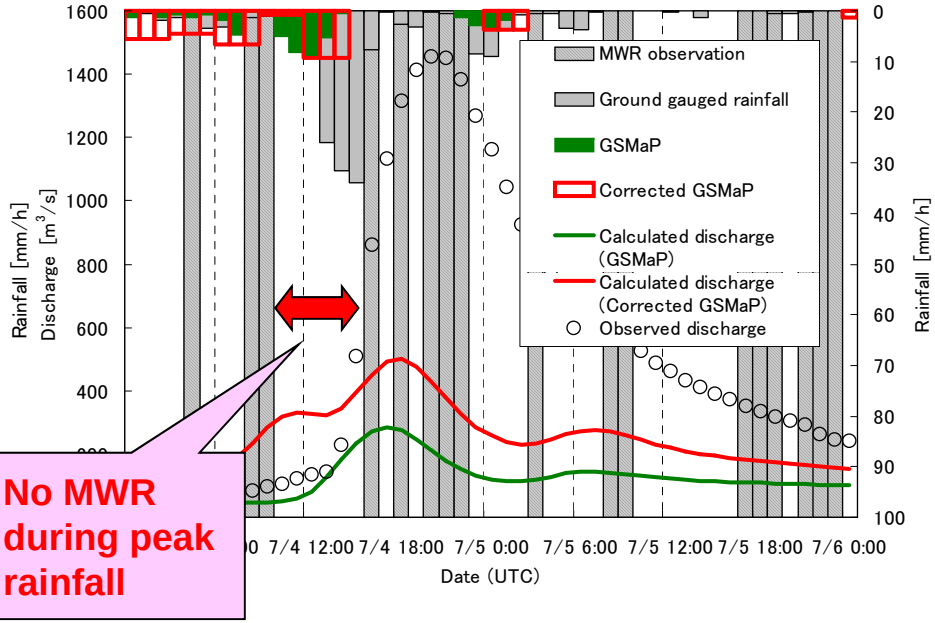


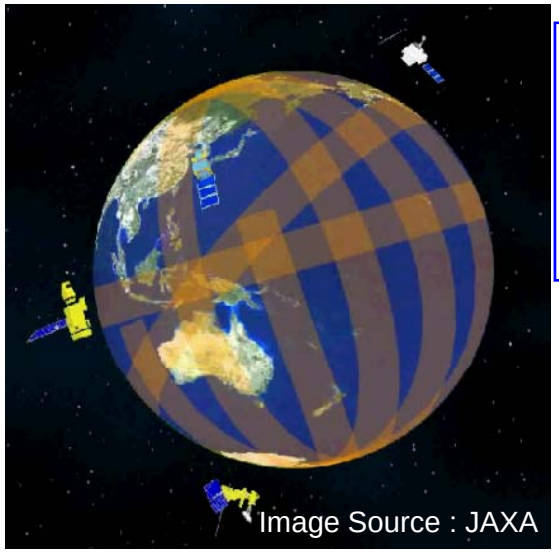
Point of consider: Difference of frequency of Microwave (MWR) observation

Successful case : Sendai river



Unsuccessful case : Kikuchi river





Accuracy of rainfall distribution depends on the frequency of MWR observations

(& accuracy of IR-based motion vectors)

Ozawa et al (2010)

← Image of microwave observation

- MWR obs. is once a few hours on average, but not always guaranteed.
-During no MWR period, rainfall field is transferred by IR-based motion vector.

Global Precipitation Measurement (GPM)

Current Observation System:
TRMM and other orbital Satellites, and 5 Geostationary Satellites

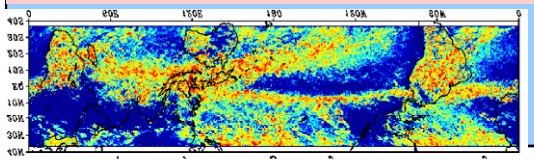
Core Satellite

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

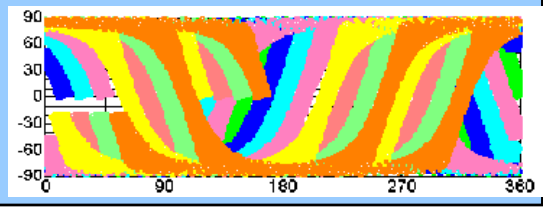


8 Constellation Satellites

Satellites with Micro-wave Radiometers

✧More frequent Observation

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

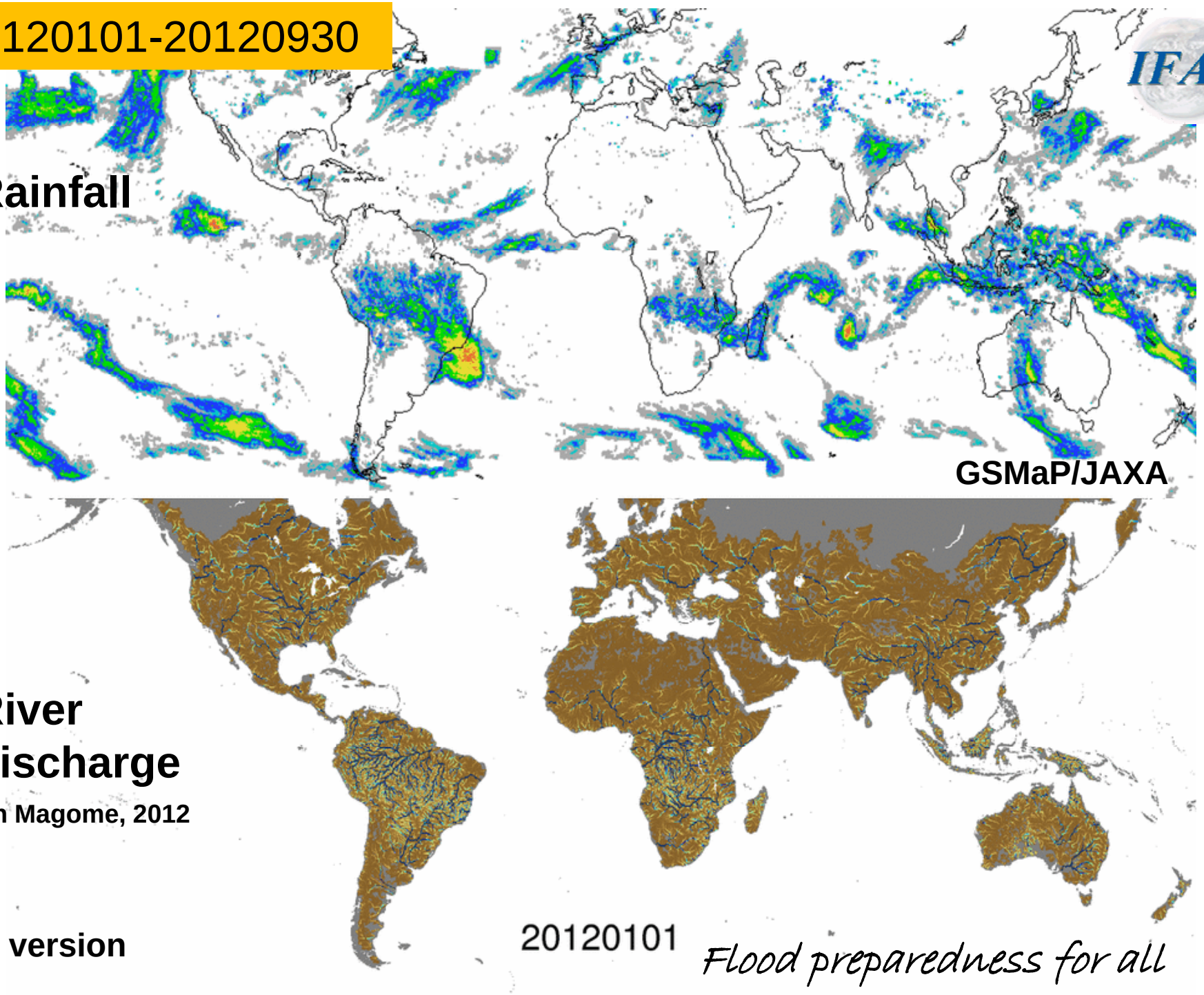


–Earth heating Phenomena
–Study of Climate Change
–Improvement of forecasting system

Global Observation every 3 hours

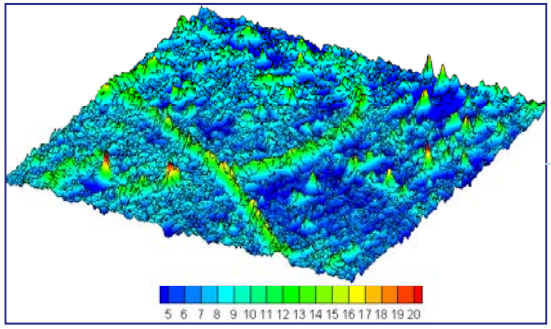
- IWRM
- Flood Forecasting
- Forecasting of crop productivity

20120101-20120930

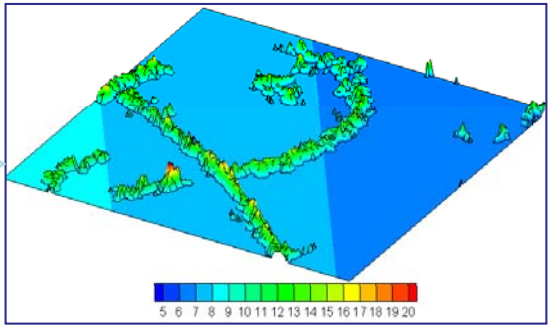


Observation of land elevation

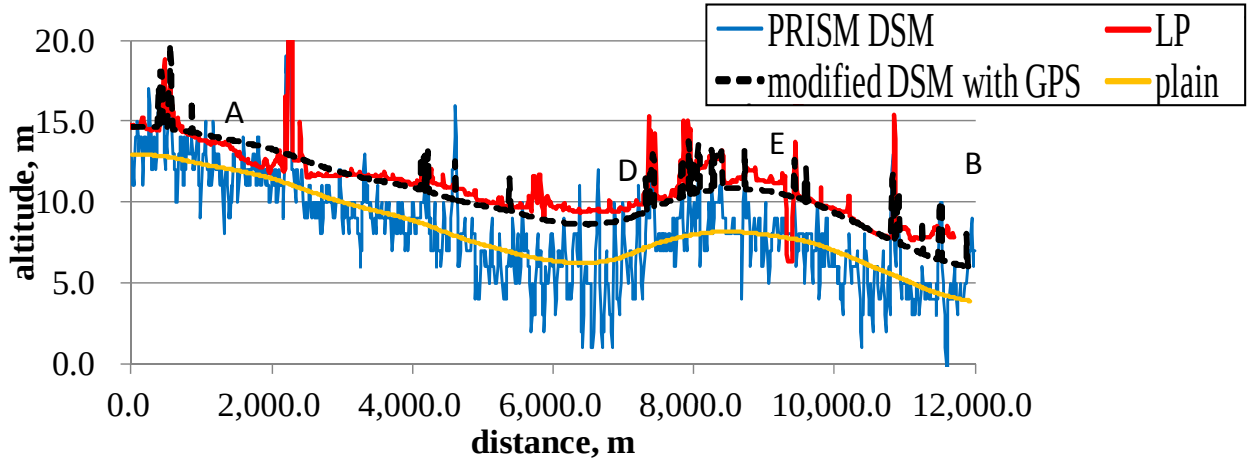
Modification method to get more accurate elevation data using satellite observation product (PRISM DSM)



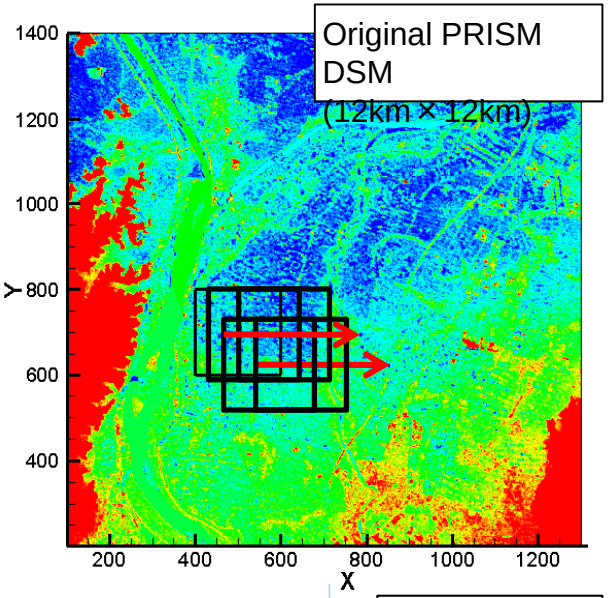
Original PRISM DSM(2km × 2km)
Including noise

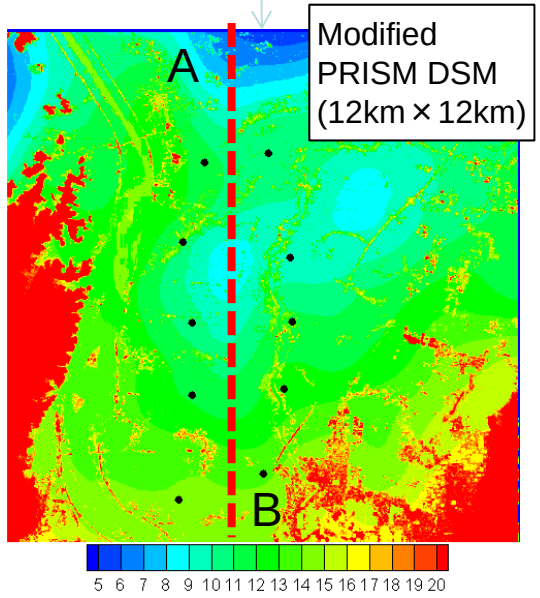


Modified PRISM DSM(2km × 2km)
Only structures are remained.



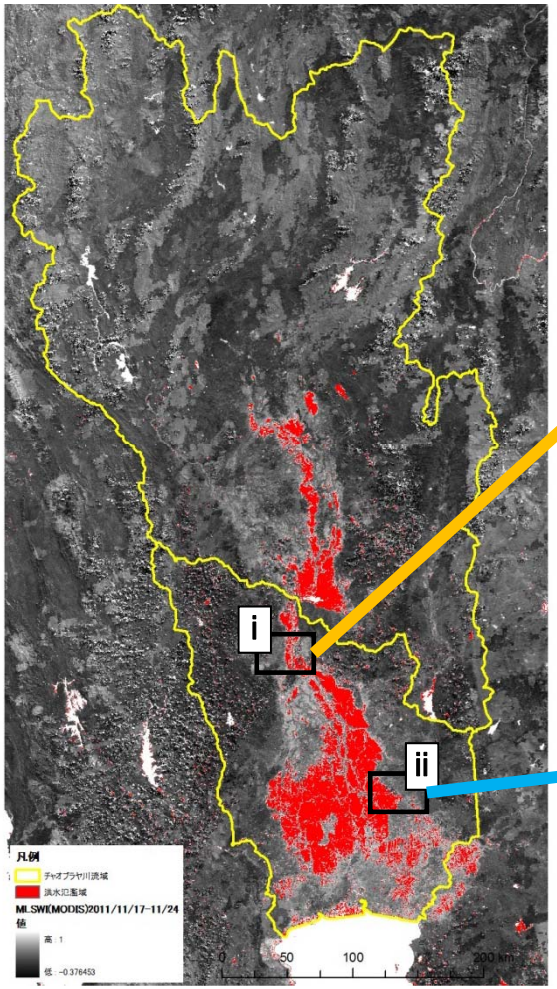
Elevation in A-B line

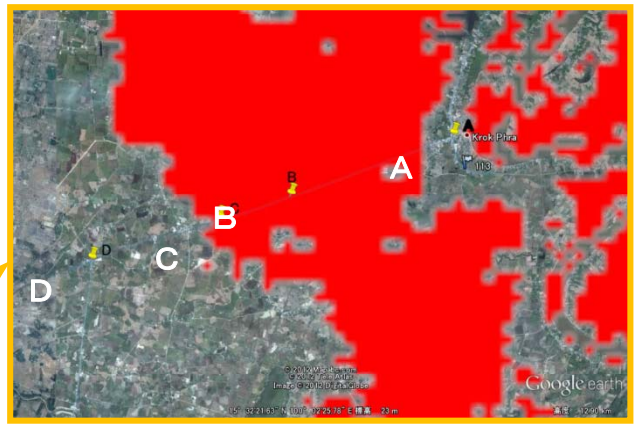




After removing structures, making <u>moving average</u> of DSM in plain area and compound the modified DSM by GPS with structures again

Detection of inundation area by using satellite data





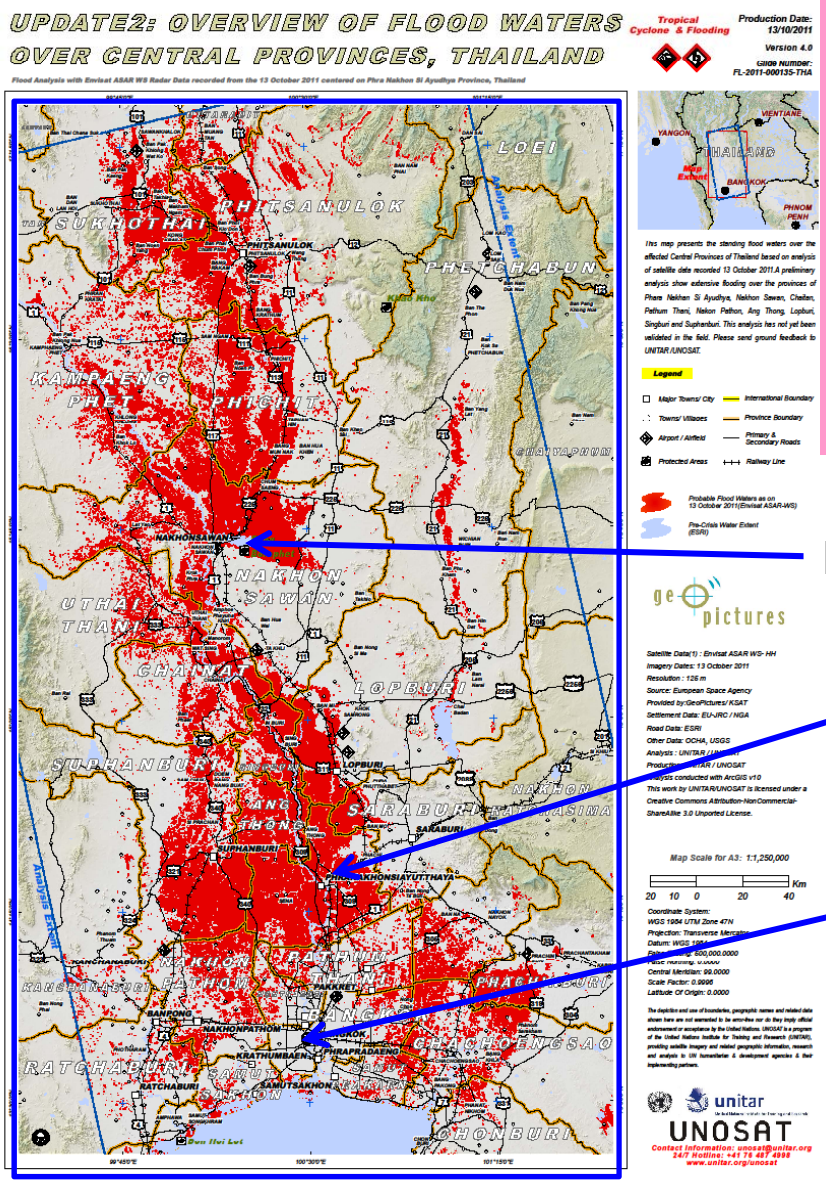
Verification of MLSWI (Modified Land Surface Water Index) with field survey

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

R: reflection rate
NIR: near infrared rays
SWIR: Short wavelength infrared

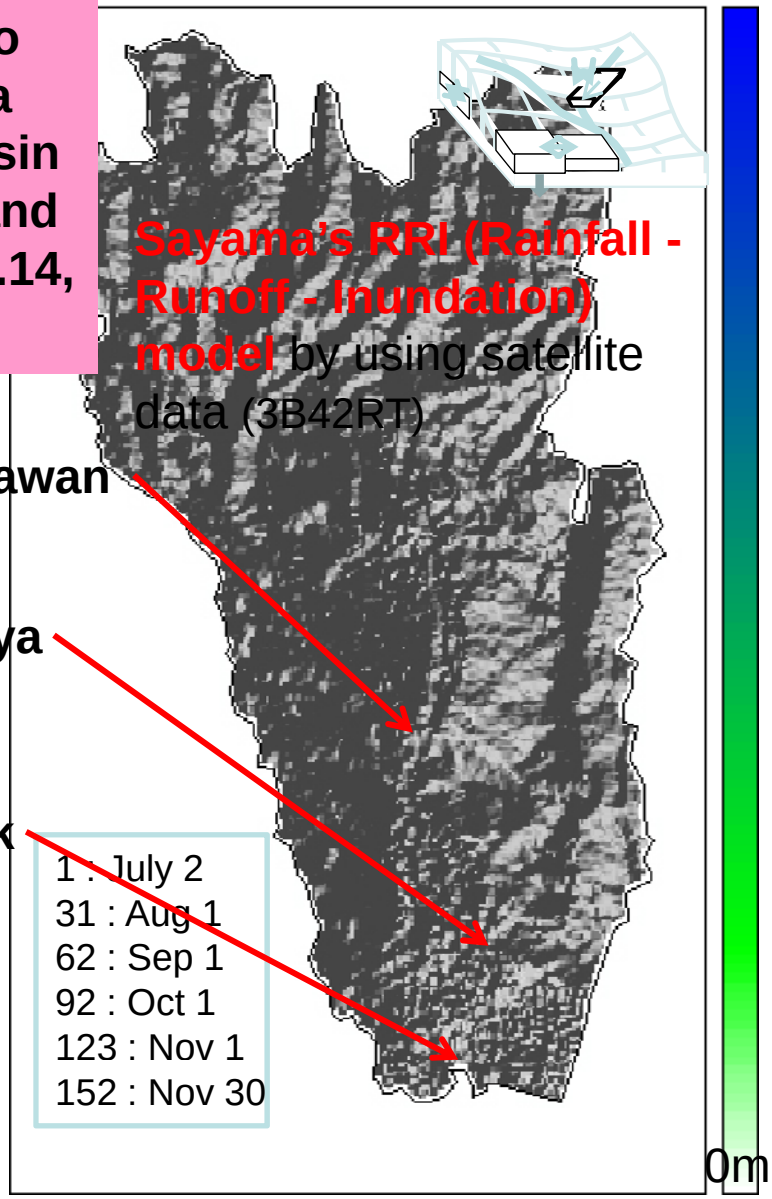
Inundation areas were detected by MLSWI from MODIS data (**2011/11/17-24**) and compared with observation of field survey (**2011/11/23-29**)

13 Oct, 2011 by MODIS



Emergency inundation Simulation in Chao Phraya river basin in Thailand as of Oct.14, 2011

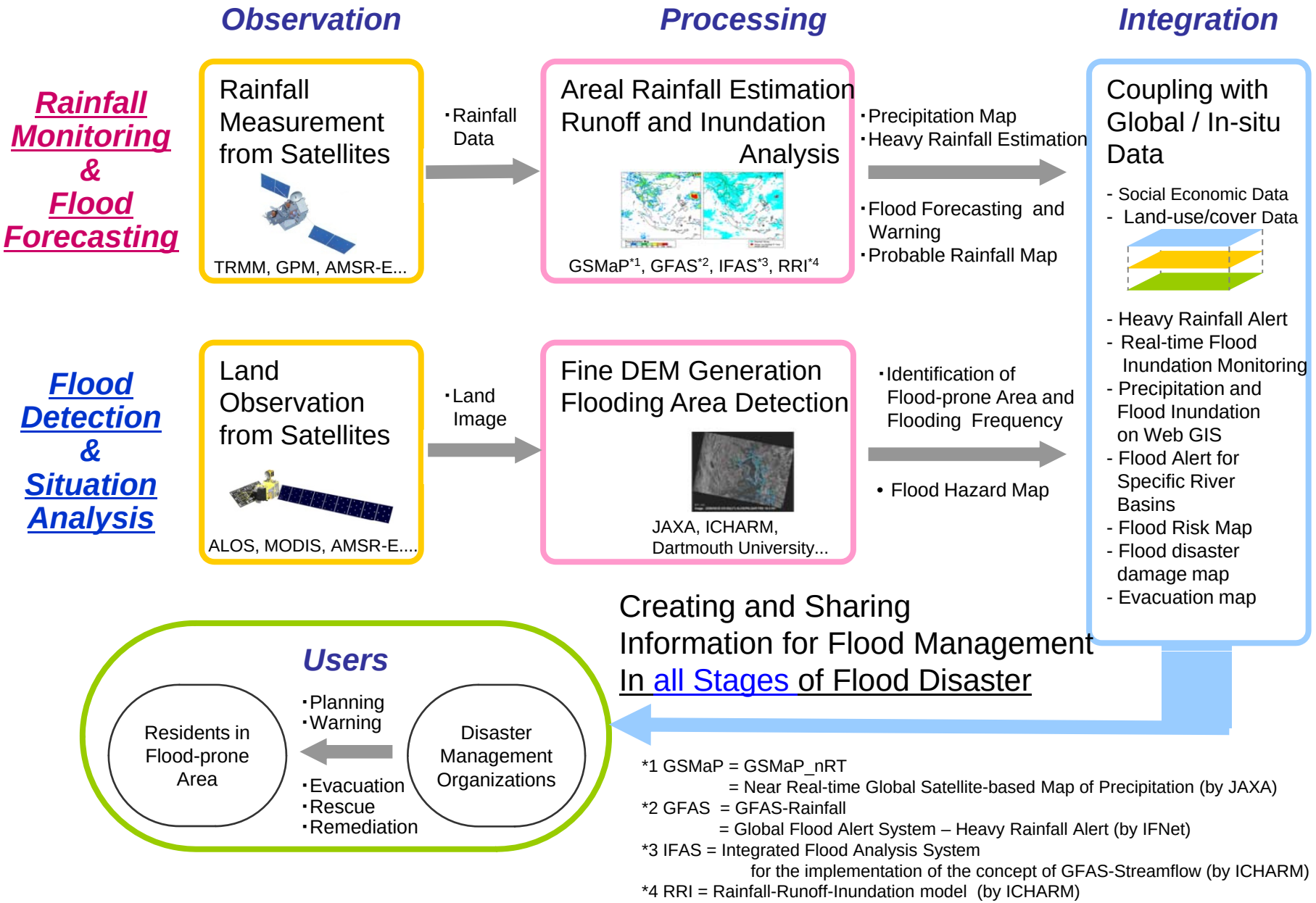
Simulation on Oct 18, 2011 by ICHARM



Objective of Flood WG in Sentinel Asia for STEP3 (2013 ～)

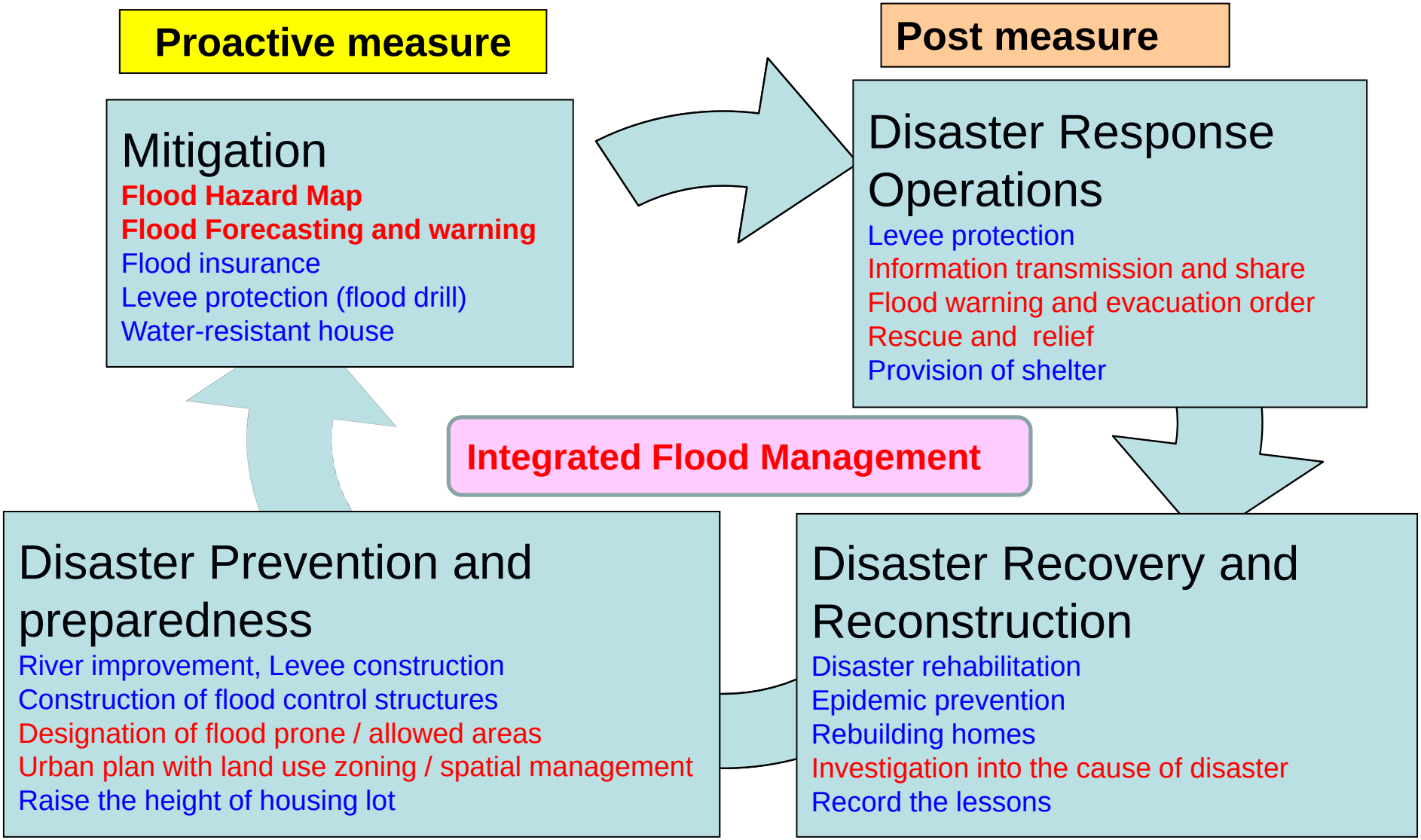
- To contribute to the mitigation of flood disasters in Asia through:
  - Developing necessary scientific & engineering information for understanding flood hazards / risks with full utilization of satellite, GIS and information network technologies, combined with in-situ data
  - Enhancing the provision and usage of such innovative information for sound decision-making in all the stages of “flood risk management cycle”
  - Sharing such experiences and achievements in Asia on the basis of Sentinel Asia network system

Concept of Flood Monitoring in Sentinel Asia



*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)

The combined use of remote sensing / GIS with hydrologic / hydraulic simulation technology will contribute to all the stages of flood risk management cycle



JICA Training program

"2013 Capacity Development for Flood Risk Management with IFAS“ by using satellite-based rainfall data

from 9 July to 6 August 2013

at ICHARM in Tsukuba, Japan

16 participants from 6 countries (Philippine, Thailand, Viet Nam, Bangladesh, Kenya, Nigeria)

Case studies:

Solo river and three other river basins

IFAS Training for ASEAN countries

"Capacity Development for Immediate Access and Effective Utilization of Satellite Information for Disaster Management"

on September 9-12, 2013 at the AHA Centre (ASEAN Coordinating Centre for Humanitarian Assistance on Disaster Management) in Jakarta

18 participants from 10 countries
(Singapore, Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Thailand and Vietnam)

Case studies:
Solo river (Indonesia)
Cagayan r. (Philippines)
Chindwin r. (Myanmar)

We are looking forward to:

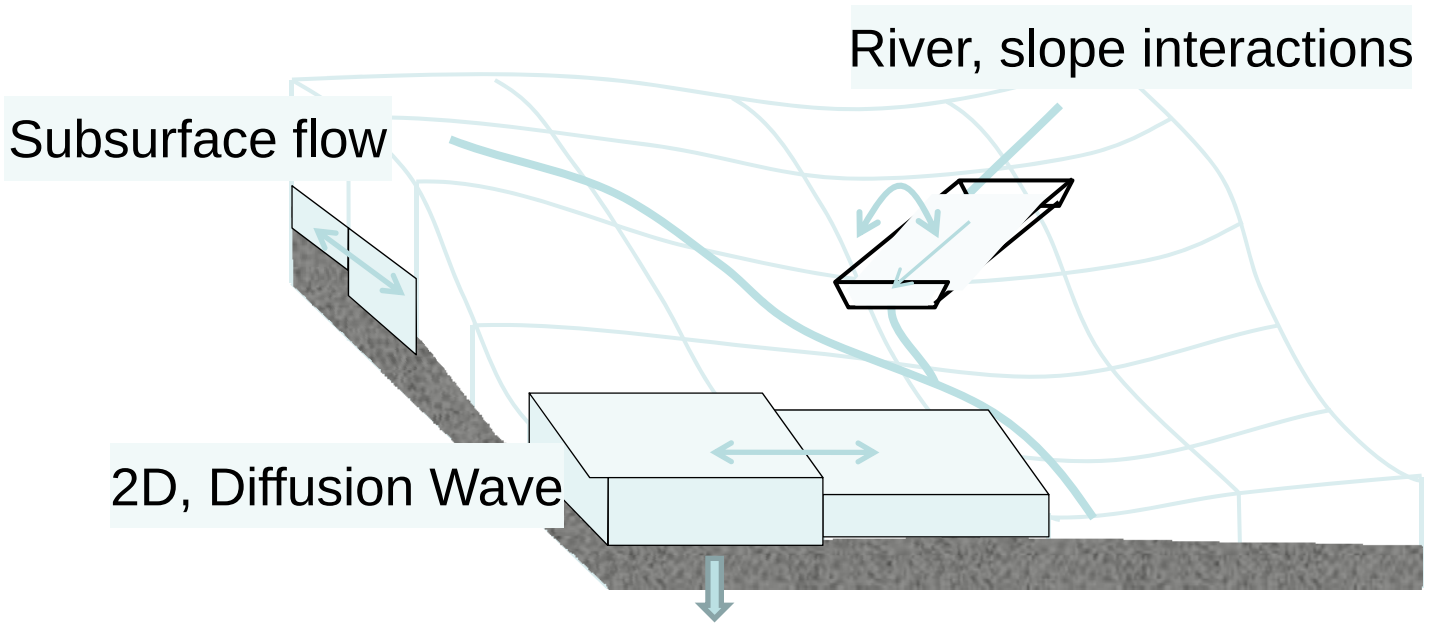
- your active trials & studies to manage flood risk and to mitigate flood disasters using opportunities available through Sentinel Asia, and

- your proposals to improve activities of Flood WG.

Thank you for your cooperation!

For IFAS free download:
http://www.icharm.pwri.go.jp/research/ifas/index.html

RRI (Rainfall – Runoff – Inundation) model



(Dr. Sayama)

- Calculating stream flow and inundation water depth together
- 2D diffusion wave model (slope)
- For large scale with relatively finer grid scale (~ 500 x 500 km with 500 x 500 m)
- Should be more suitable to relatively flat regions, where flow directions cannot be determined by topography (where flow directions cannot be determined by DEM only)
- Maybe useful for flood risk assessment that requires inundation depths information.