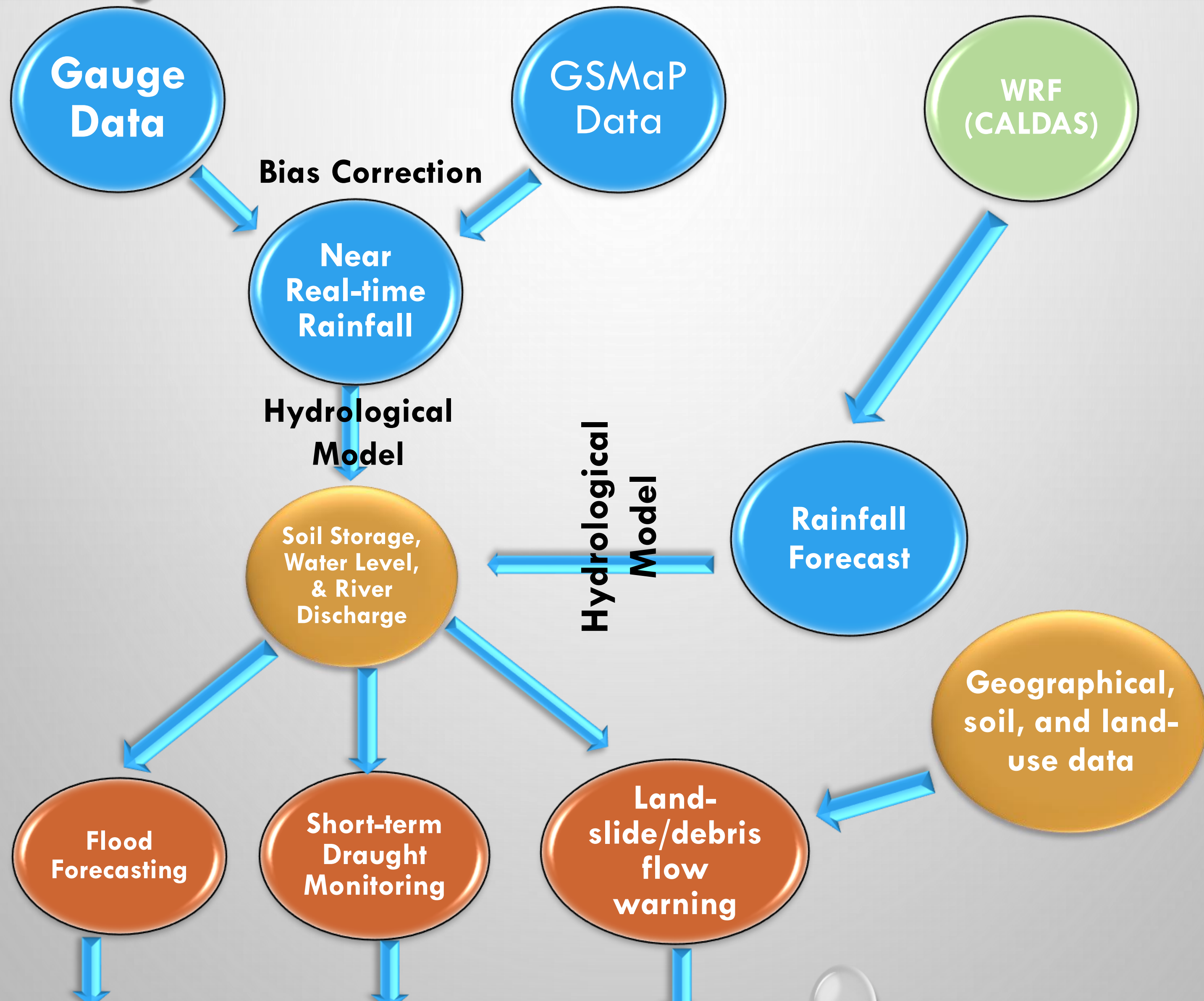
ICHARM's activities for Sri Lanka

1. Rainfall forecast model and prediction method (Hiroyuki ITO)
2. Application of bias correction technique of GSMaP on Kalu basin (Morimasa TSUDA)
3. Real-time rainfall monitoring & hydrological modeling in Kalu river basin (Mohamed RASMY)
4. Warning and evacuation for sediment disasters (Yusuke YAMAZAKI)
5. Overall Scheme on Emergency Support for Flood Management in Sri Lanka (Tetsuya IKEDA)

August 24, 2017

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

ICHARM's Activities for Sri Lanka



Socio-economic Benefits:

Hazard Maps & Disaster Early Warning, Assessment of Risk and Damages

System Development & Integration

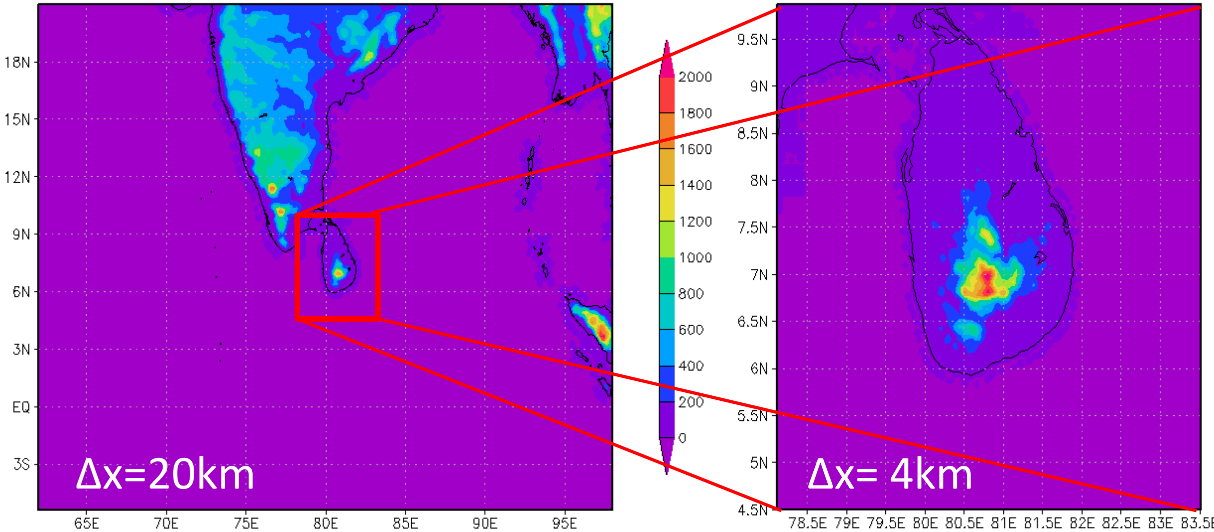
Dissemination through DIAS

Rainfall forecast model and prediction method

Hiroyuki ITO

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

Rainfall forecast model and prediction method



WRF model:

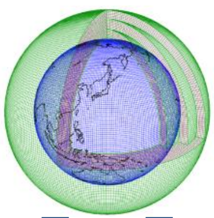
Resolution: 20km/4km

Grids: 200 × 150 × 40 (outer), 151 × 151 × 40 (inner)

Cumulus parameterization: Newer Tiedtke in outer frame

Cloud microphysics: Lin (water cloud, ice cloud, rain, graupel, snow, single moment)

Forecast initial time (NCEP GFS)

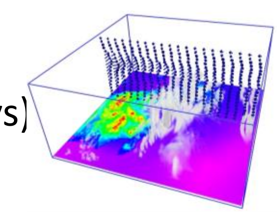


5/30				5/31				6/1			
00	06	12	18	00	06	12	18	00	06	12	18 (UTC)

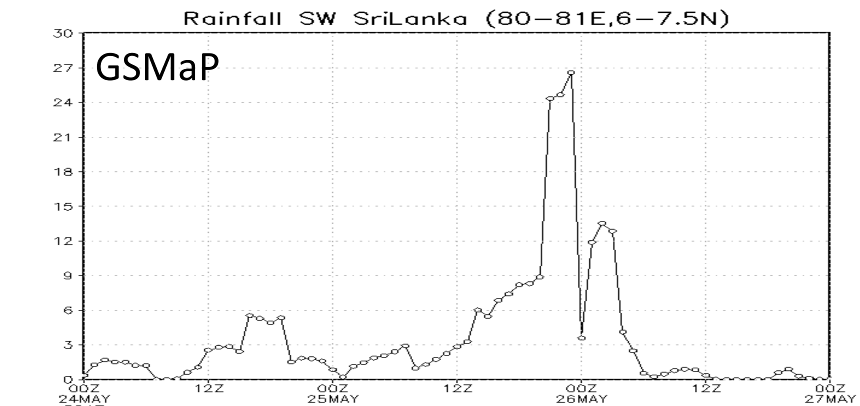
Forecast from 18UTC is available at around 01UTC next day.

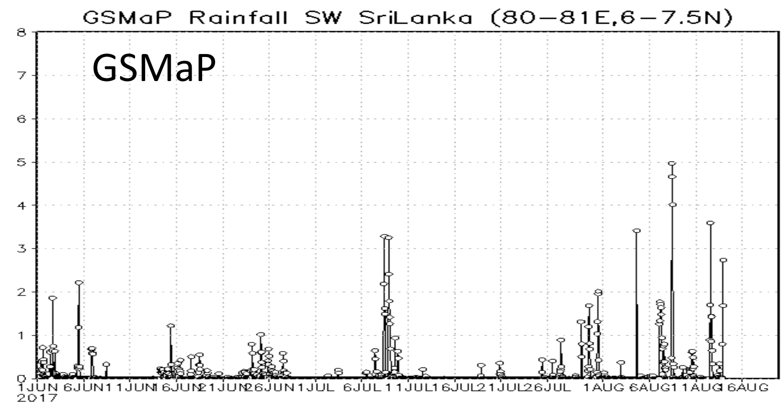
Global forecasts available

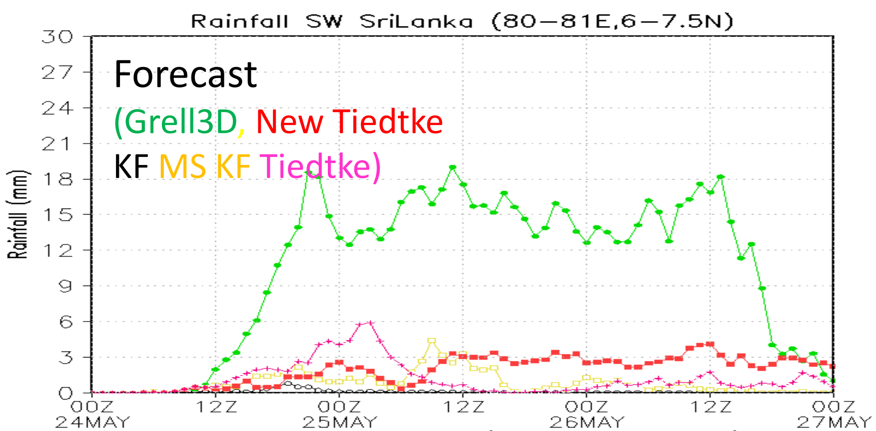
Downscaled forecast (3days) is available.

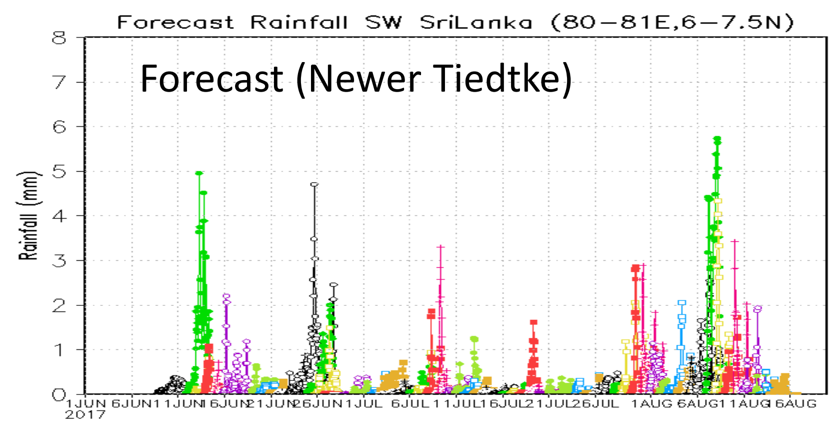


GSMaP vs. Forecast

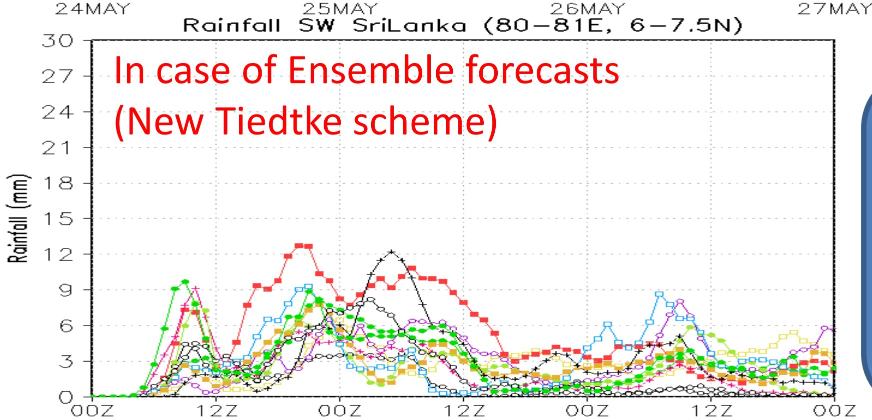








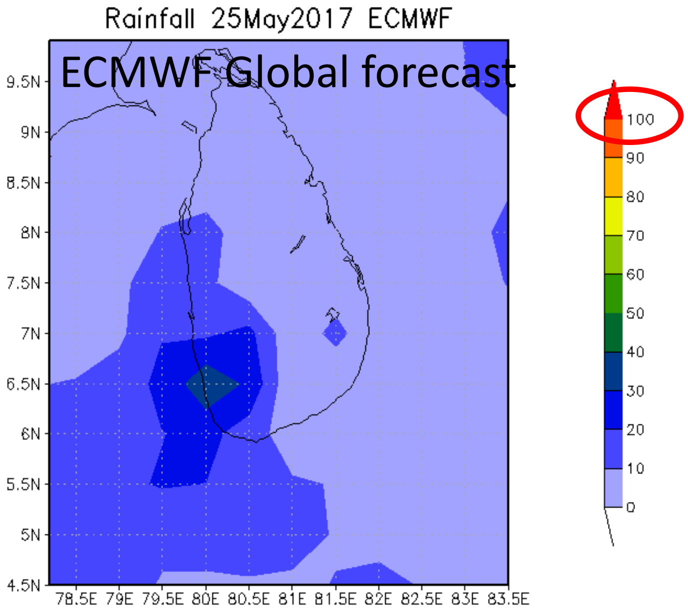
1Jun. 1Jul. 1Aug. 15Aug.

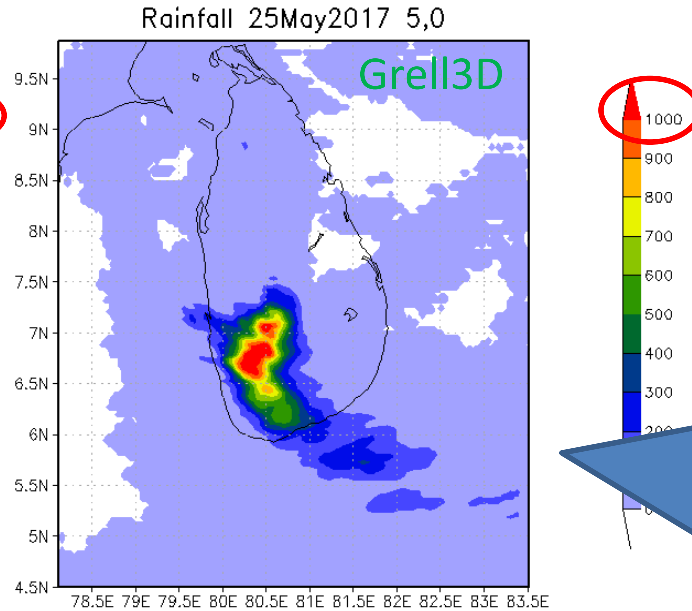


The forecast model could not predict sudden increase of rainfall. An ensemble forecast was better but still couldn't.

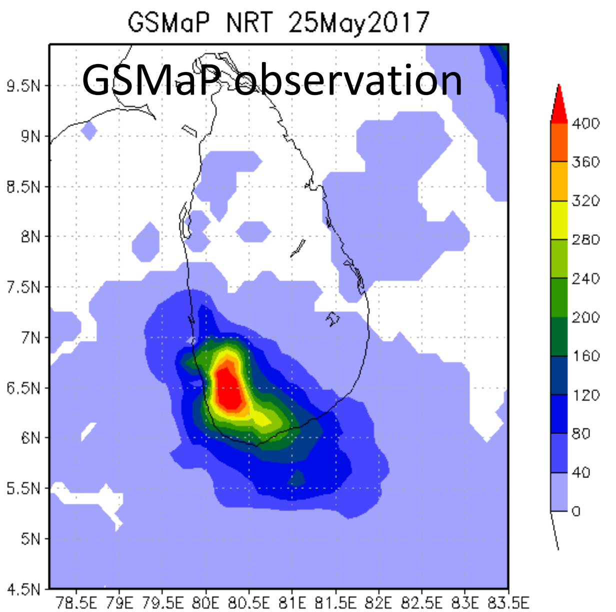
The tendency of convective activity is more or less predicted.

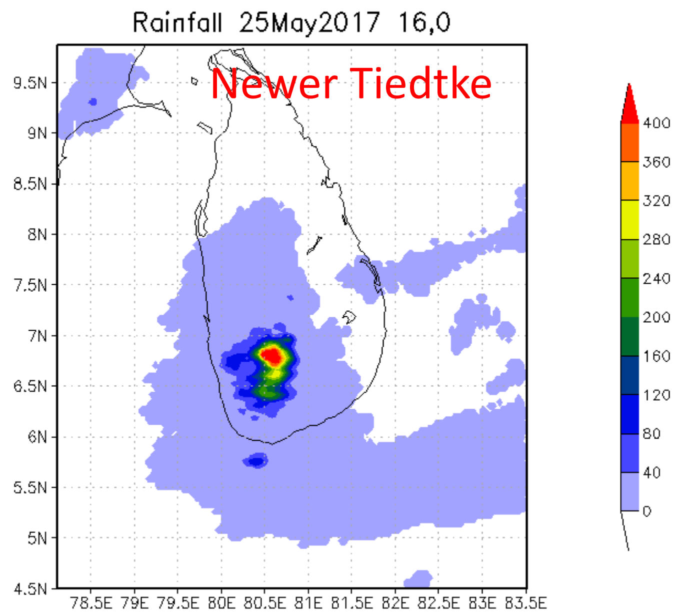
Forecast Rainfall in 25May2017





The location of precipitation is well predicted, but is overestimated or underestimated depend on the choice of cumulus scheme.





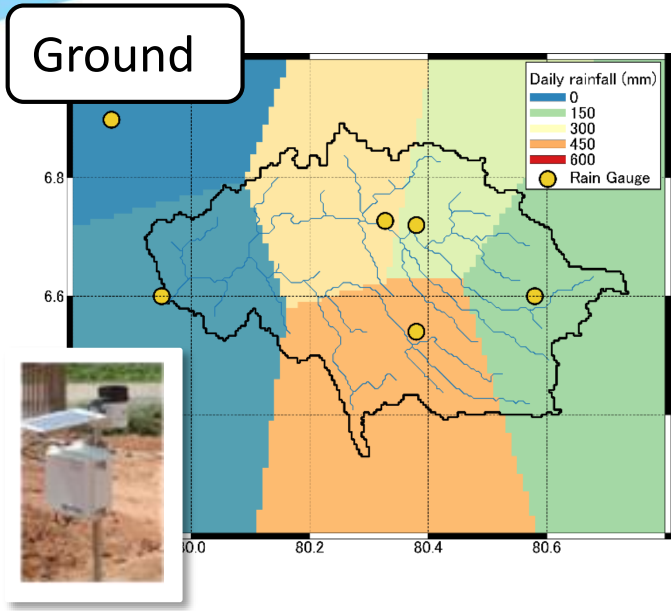
Plenary Session for the Platform on Water and Disasters in Sri Lanka

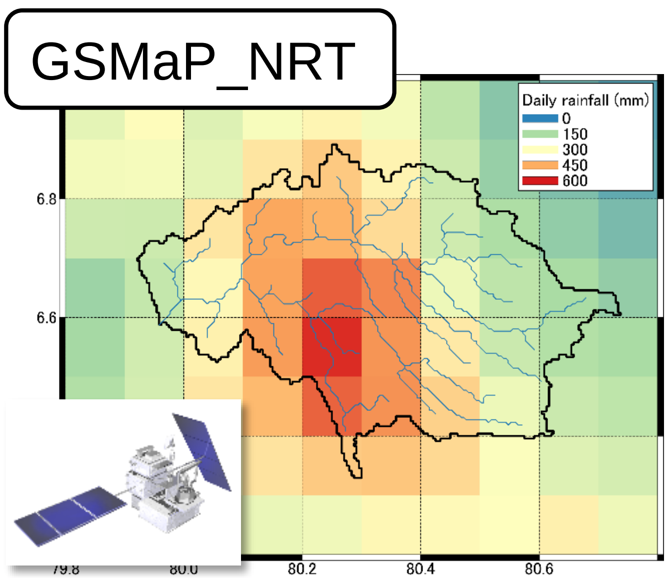
Application of bias correction technique of GSMaP on Kalu basin

Morimasa Tsuda

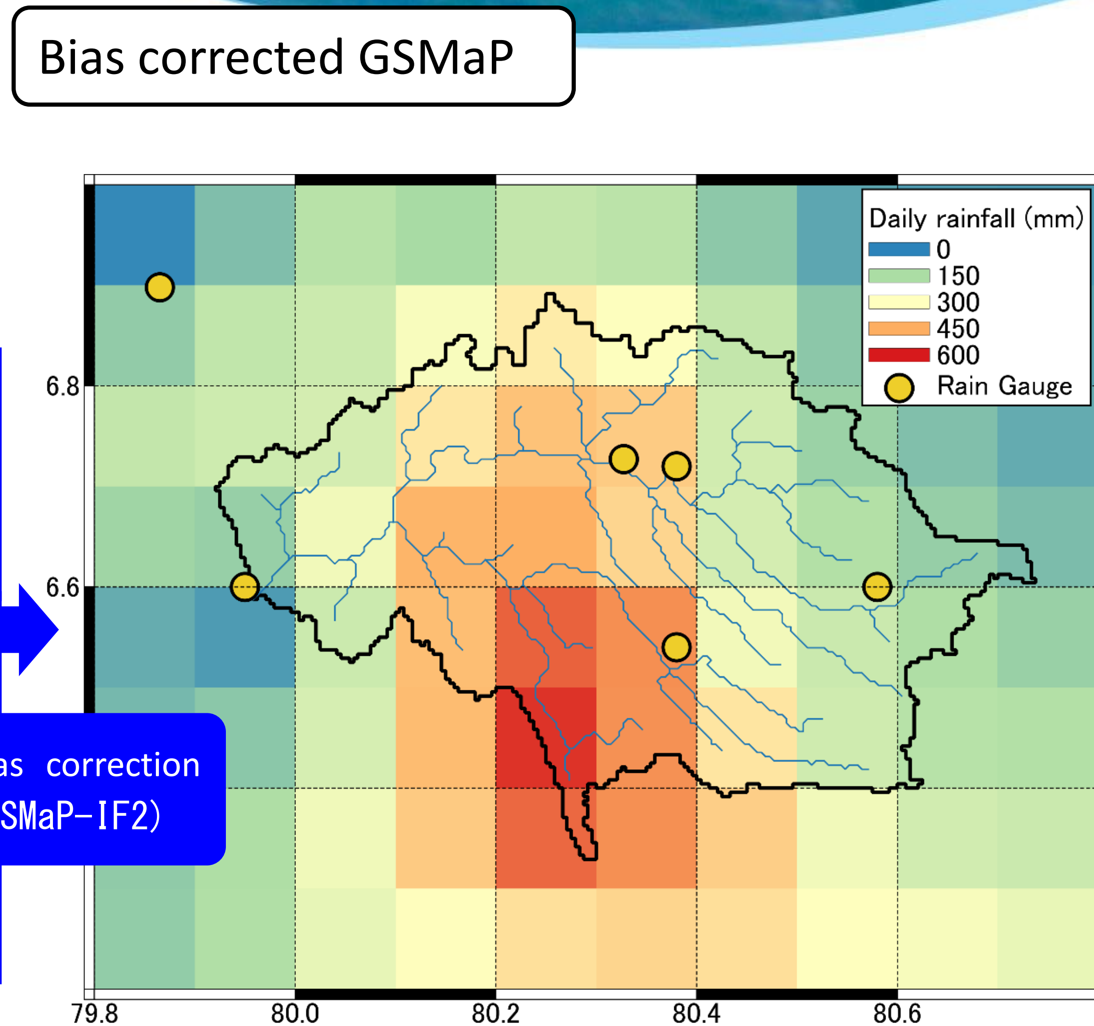
International Centre for Water Hazard and Risk Management under the auspices of UNESCO (ICHARM)

Bias correction of satellite rainfall using ground observation



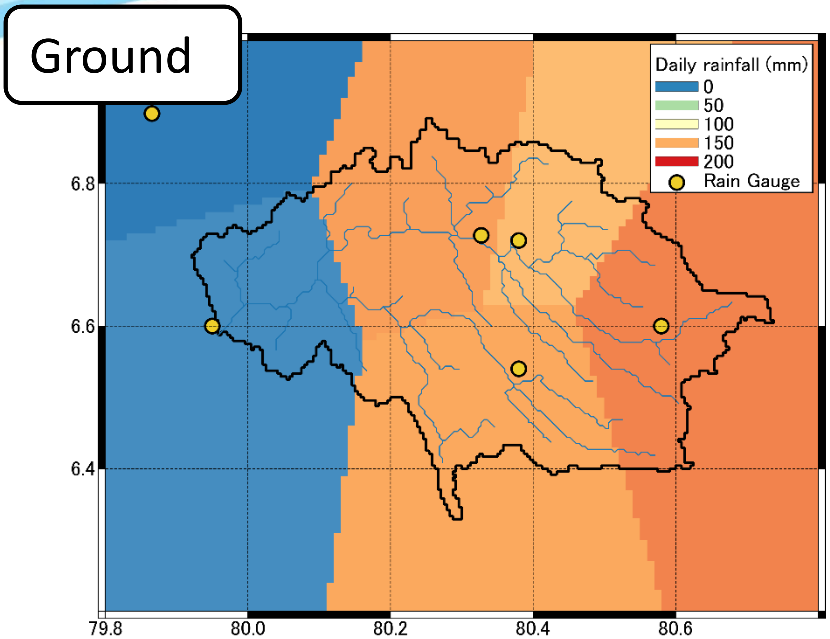


Bias correction
(GSMaP-IF2)



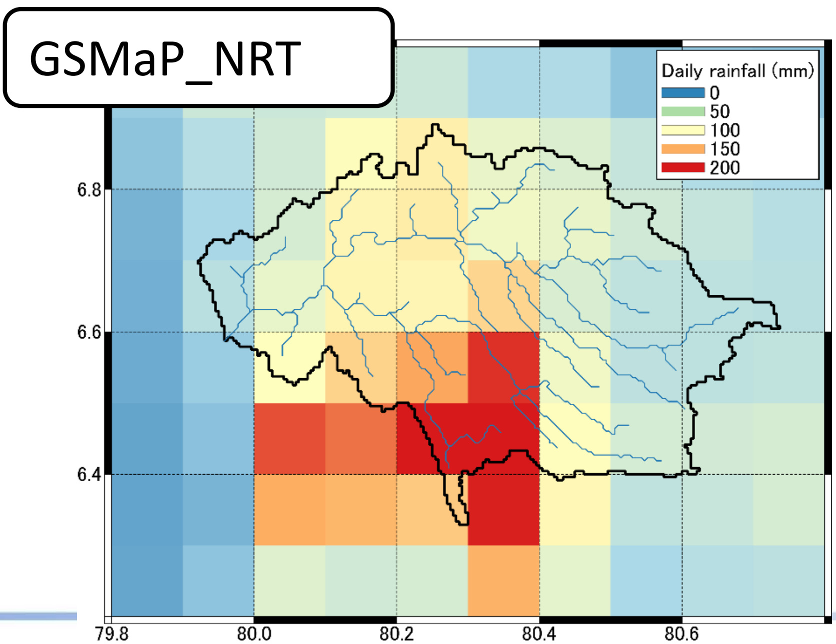
25 May 2017, Kalu basin

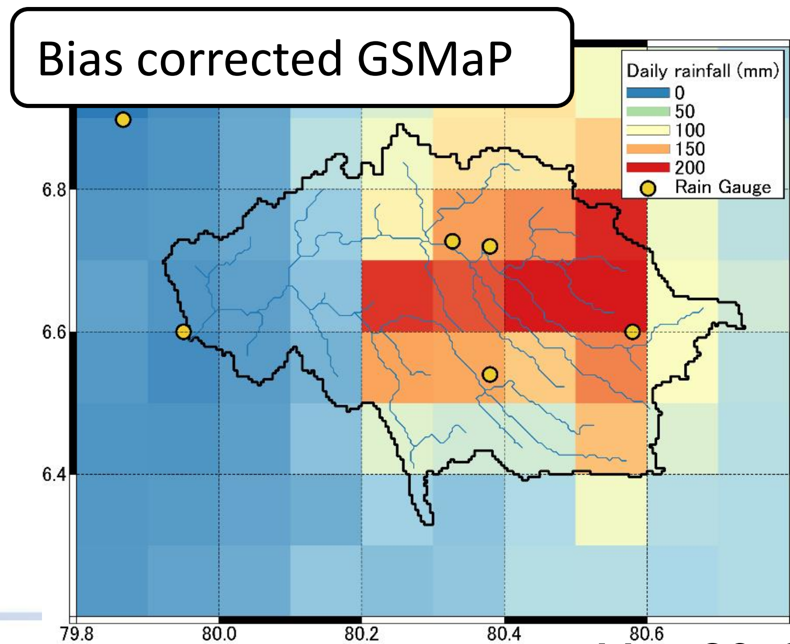
Geolocation error correction



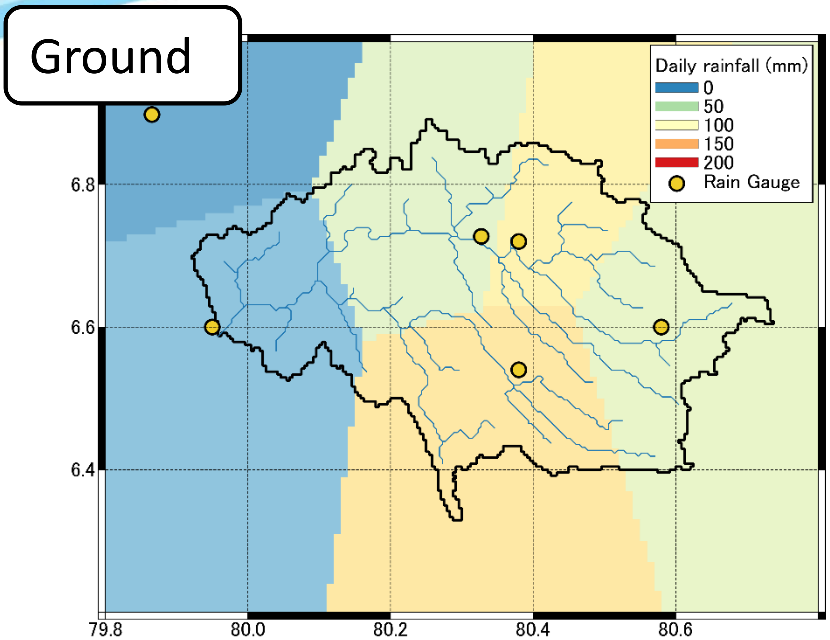
Error of rainfall area location (Geolocation error)

Geolocation error is corrected by comparison of rainfall pattern



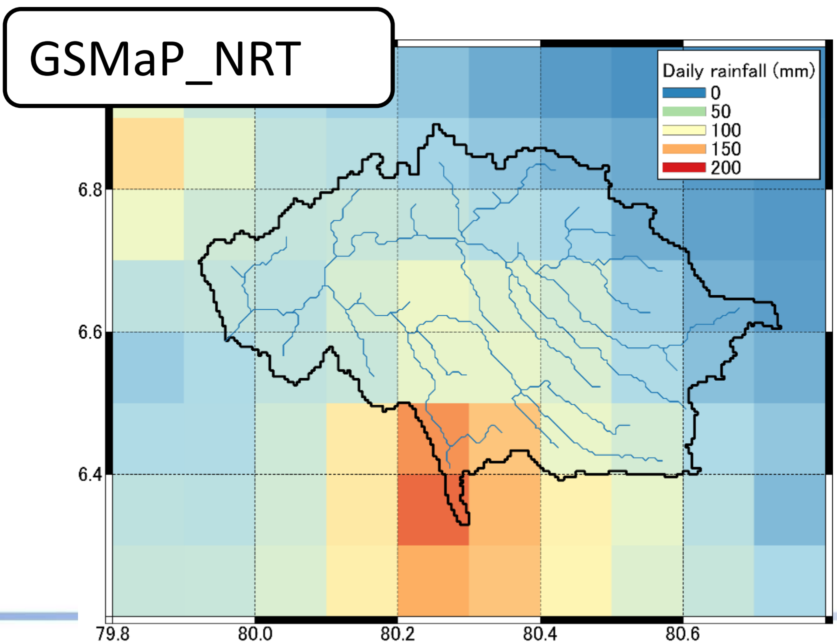


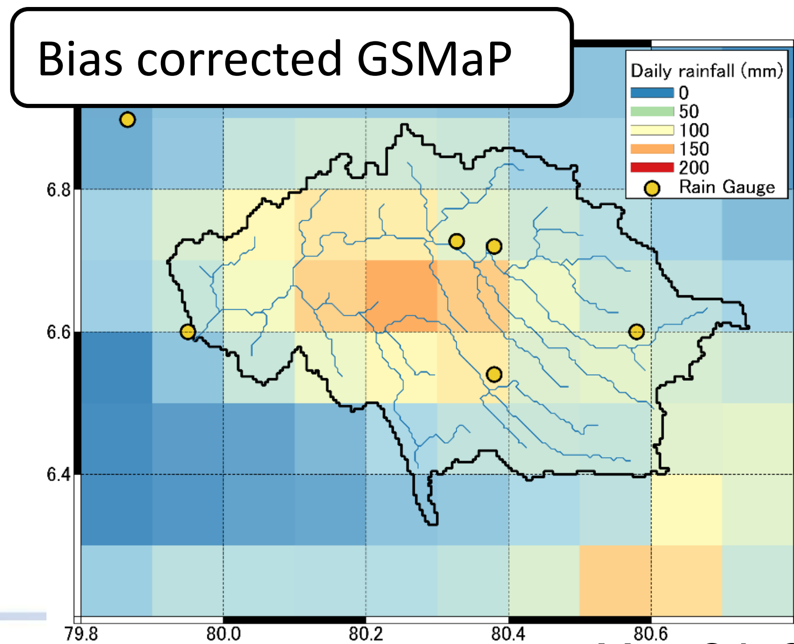
Rainfall intensity correction



Bias of rainfall intensity

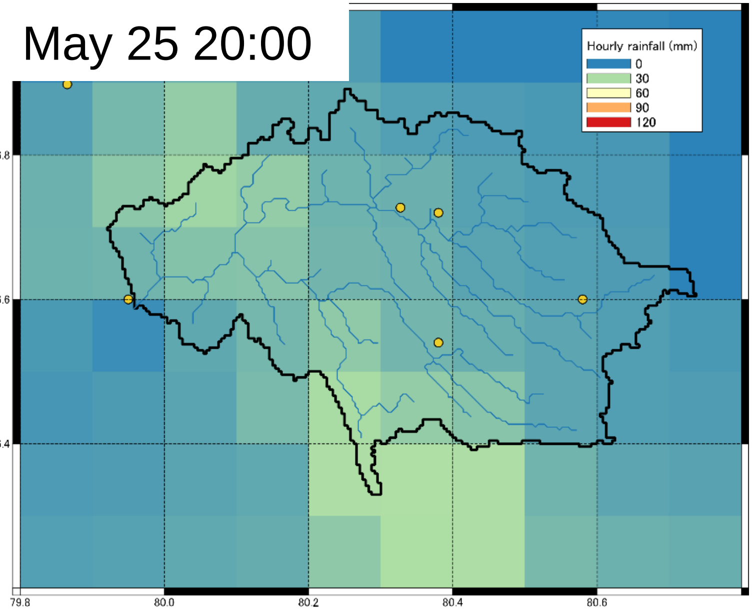
Rainfall intensity is adjusted using information of ground observation



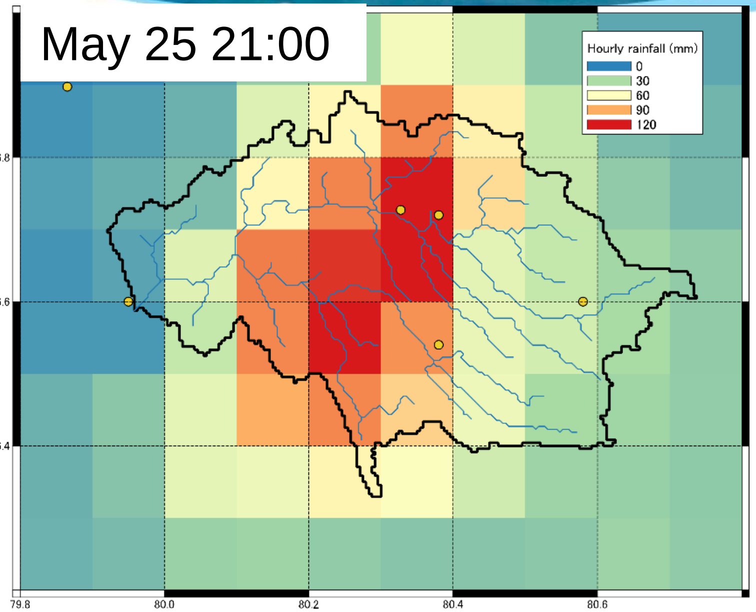


Example of hourly rainfall (Corrected GSMaP)

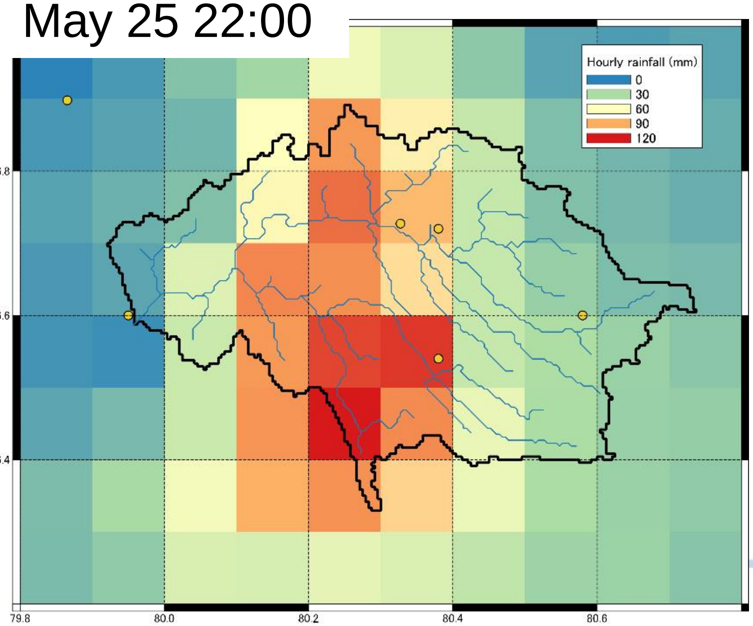
May 25 20:00



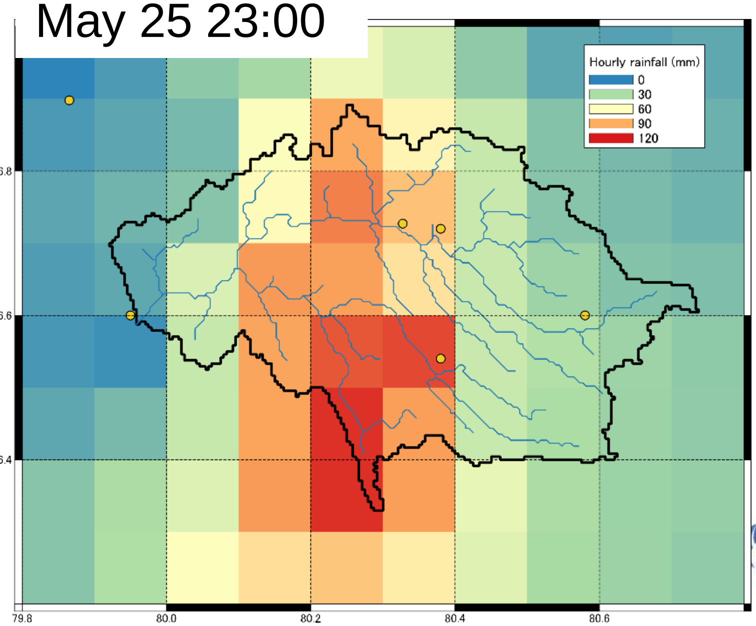
May 25 21:00



May 25 22:00



May 25 23:00



ICHARM

Real-Time Rainfall Monitoring

&

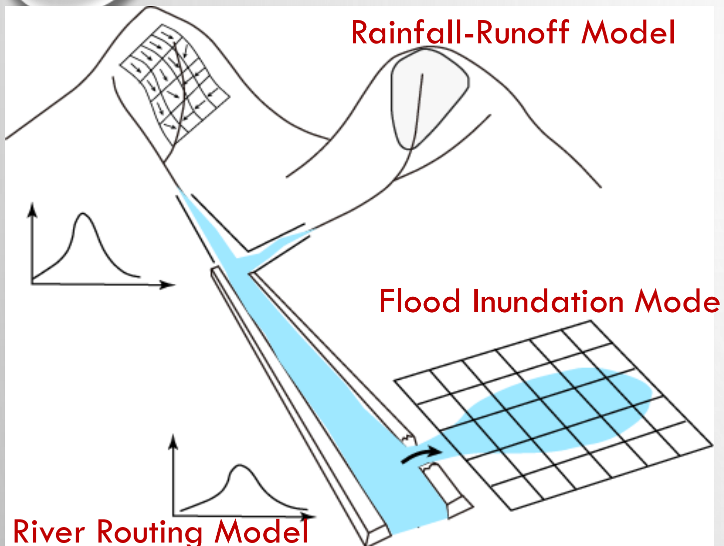
hydrological Modeling in Kalu River basin

Mohamed Rasmy (Senior Researcher)

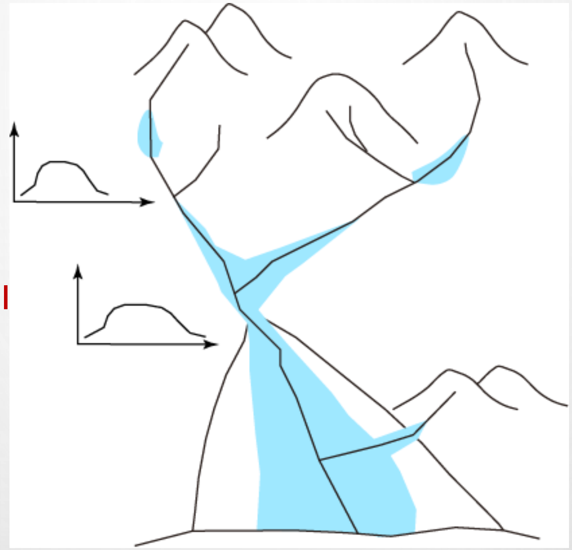
International Centre for Water Hazards and Risk Management (ICHARM)

Public Work Research Institute (PWRI)

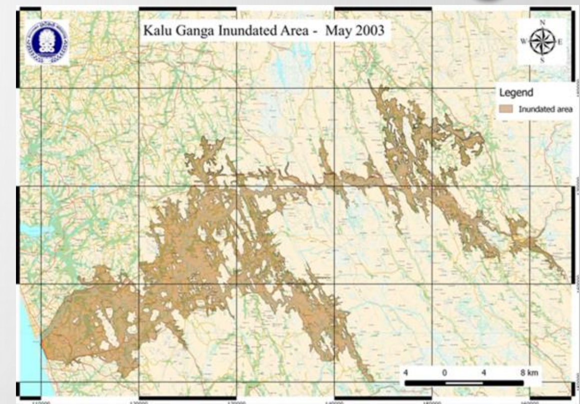
Rainfall-Runoff-Inundation Model



e.g. Japanese River Case



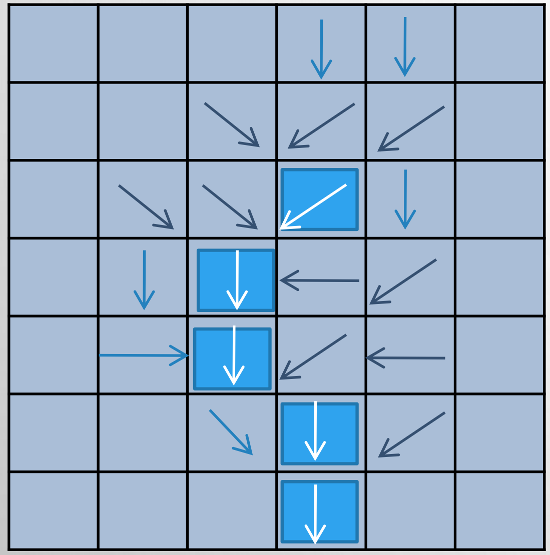
e.g. Chao Phraya River Case



Kalu River - Inundation

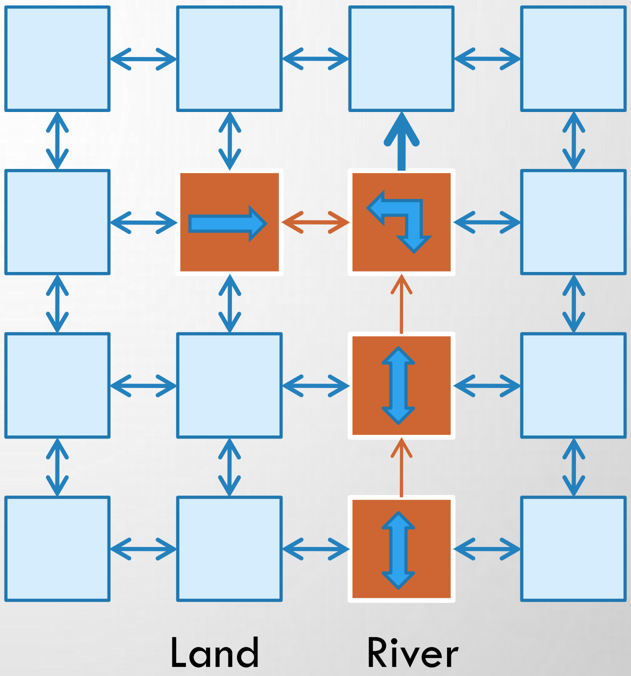
- ✓ Ordinary Rainfall-Runoff models are incapable of simulating inundation effects due to kinematic wave
- ✓ Flood inundation models are typically designed for floodplains with boundary conditions from a breaching point (not suitable for large scale flooding).
- ✓ Rainfall-runoff and inundation processes should be simulated simultaneously for some cases e.g evacuation, risk assessment

Kinematic Wave Vs Diffusive Wave Approach



Distributed R-R Model
Kinematic Wave Approach

Flow directions are fixed based on topography



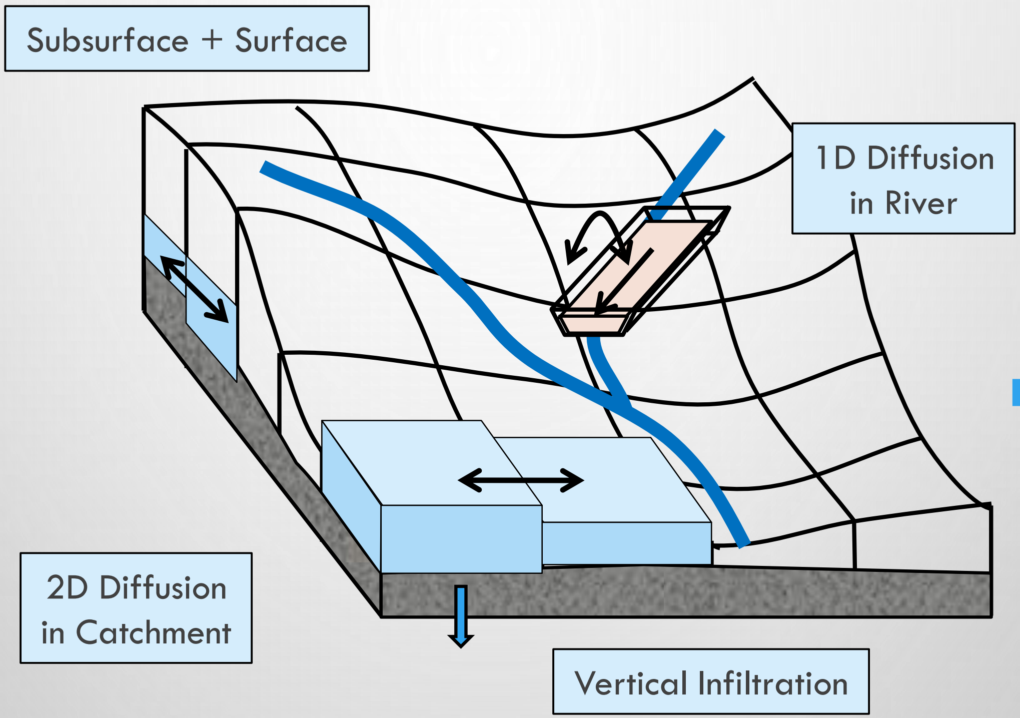
Distributed R-R Model
Diffusive Wave Approach

Flow directions change based on water levels

Rainfall – Runoff – Inundation (RRI) Model

Input

- Rainfall
- DEM
- Land Cover
- Cross Sec.



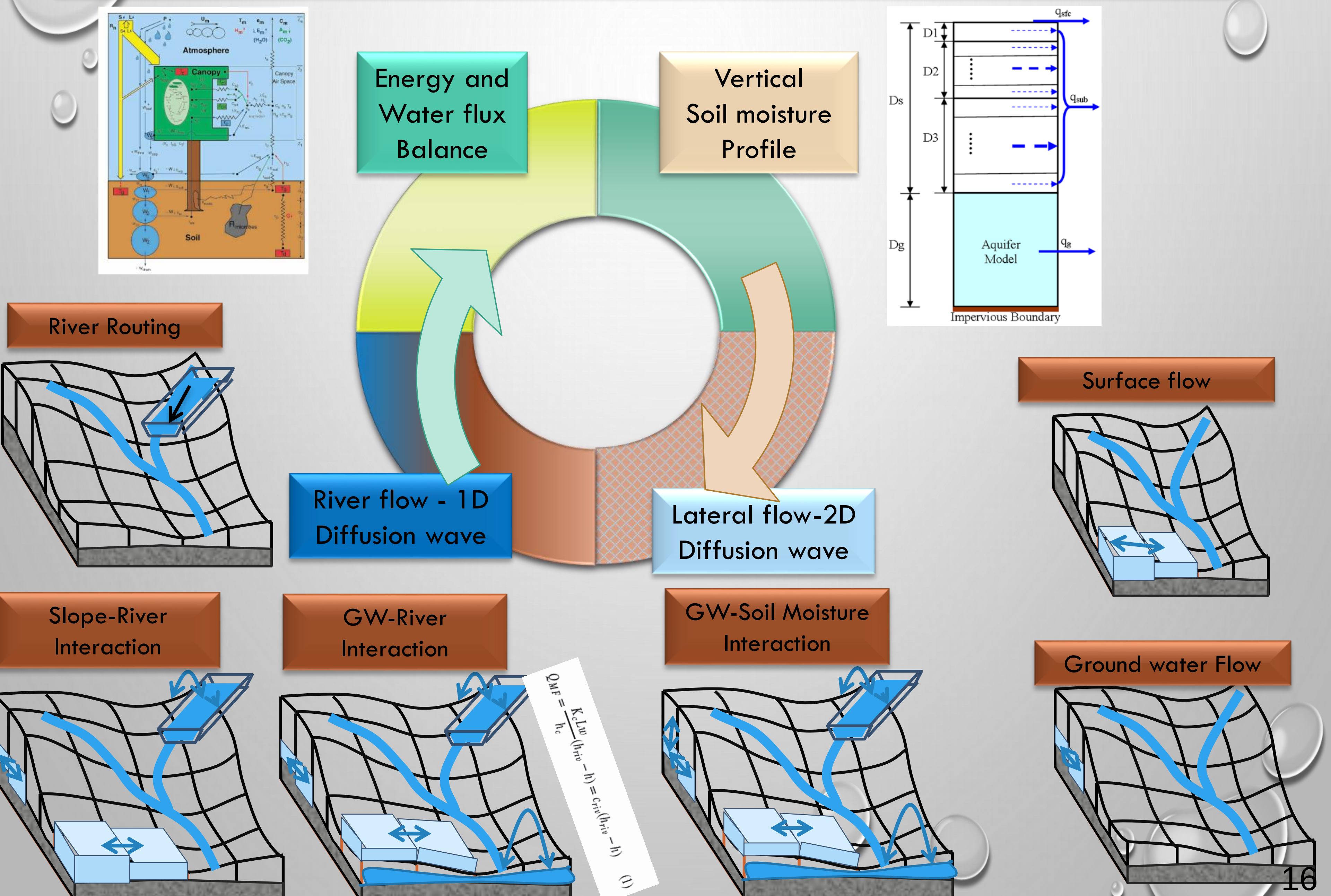
Output

- Discharge
- W. Level
- Inundation

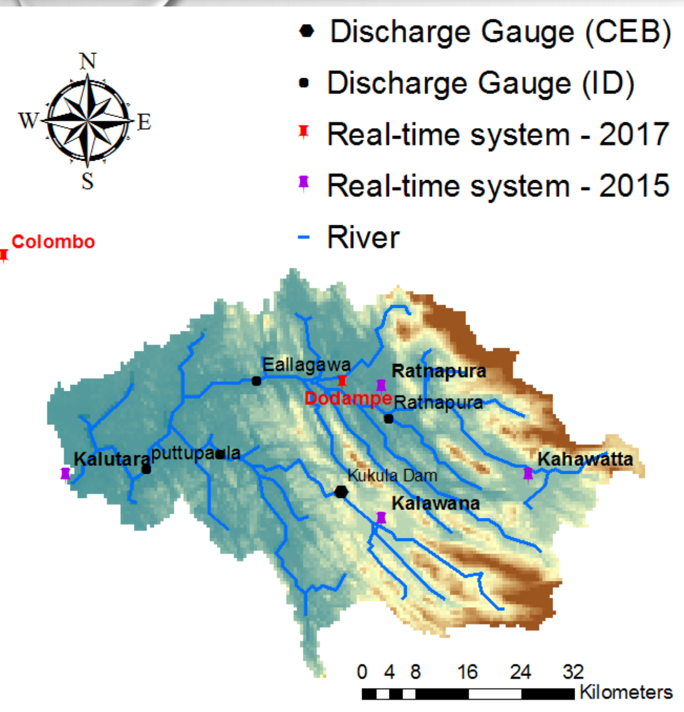
- Two-dimensional model capable of simulating rainfall-runoff and flood inundation simultaneously
- The model deals with slopes and river channels separately
- At a grid cell in which a river channel is located, the model assumes that both slope and river are positioned within the same grid cell

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.

Water-Energy budget-RRI (WEB-RRI) Model

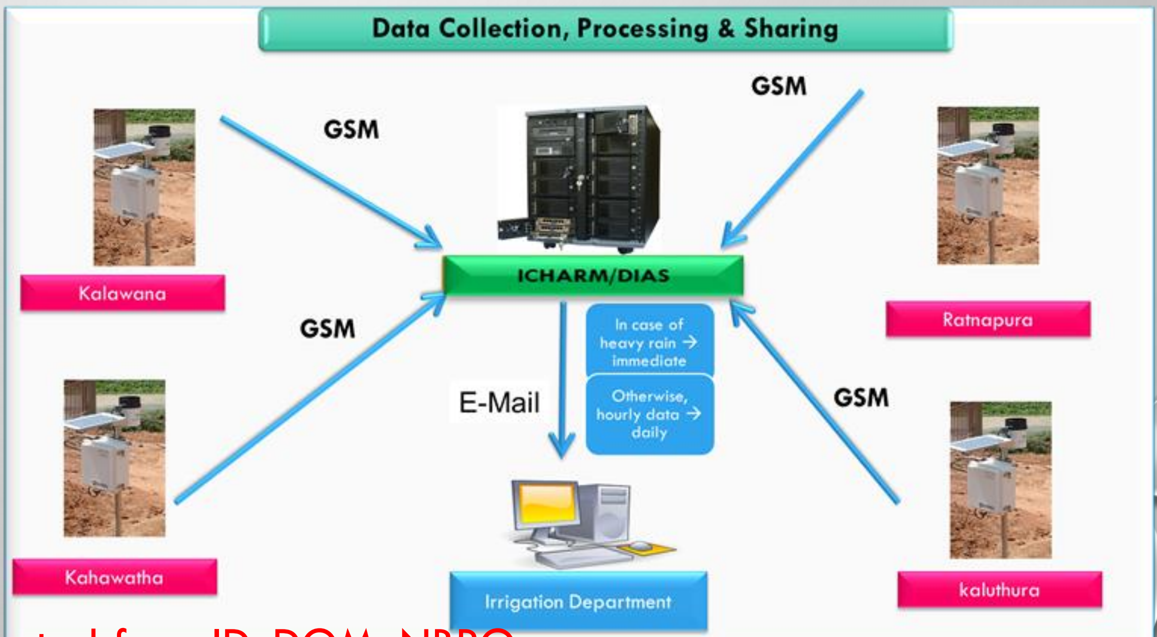


Kalu River Basin: Real-time rainfall monitoring & Modeling



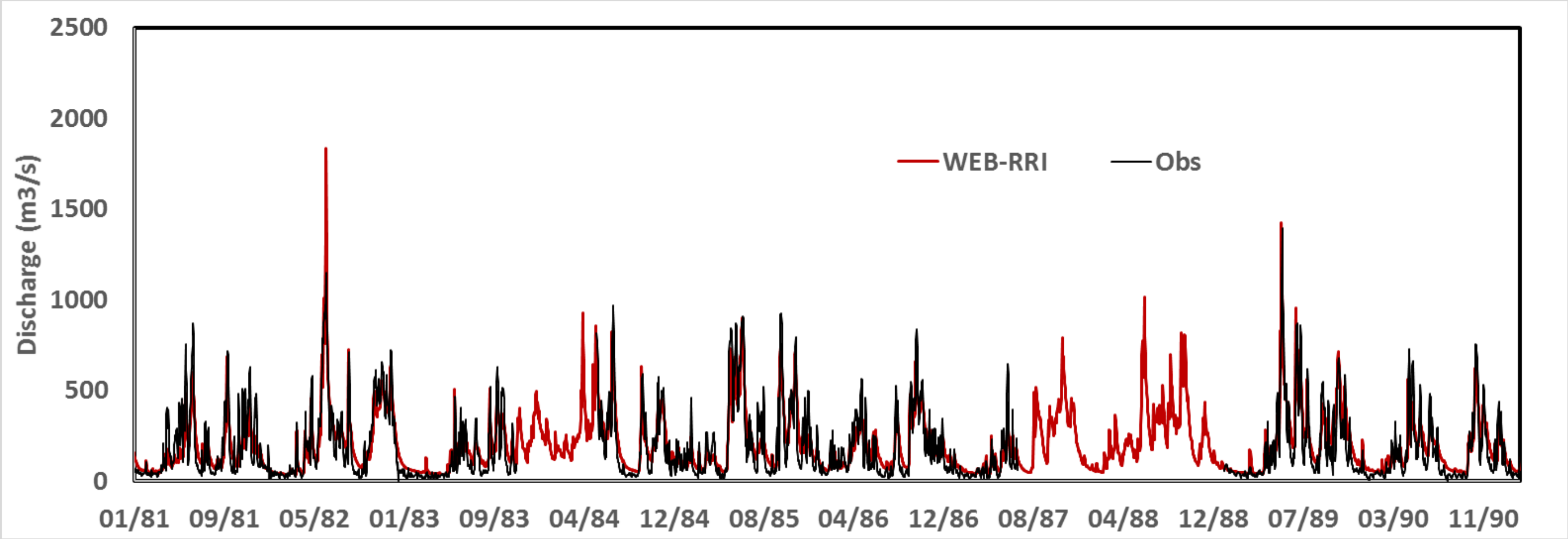
- ✓ **Catchment area 2839km2**
- ✓ **Largest Discharge to sea 4035MCM annually**
- ✓ **Highest Rainfall**
- ✓ **Length 129km**

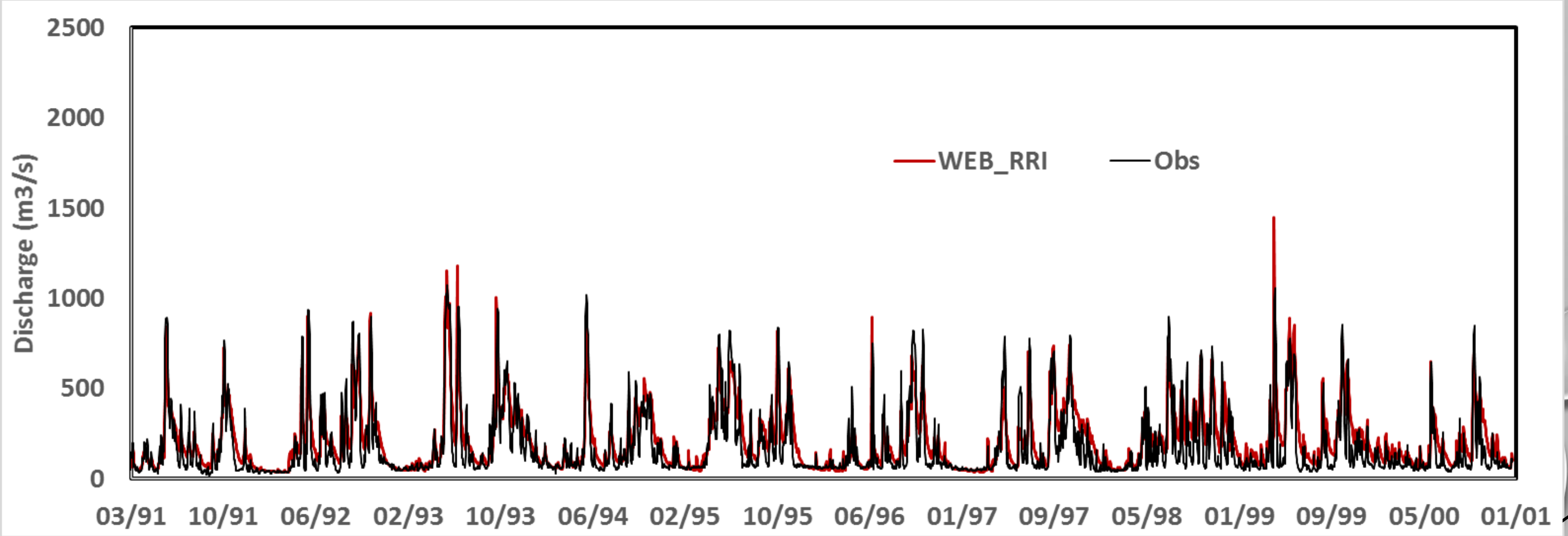
Real-Time Data Transfer System in Kalu Basin



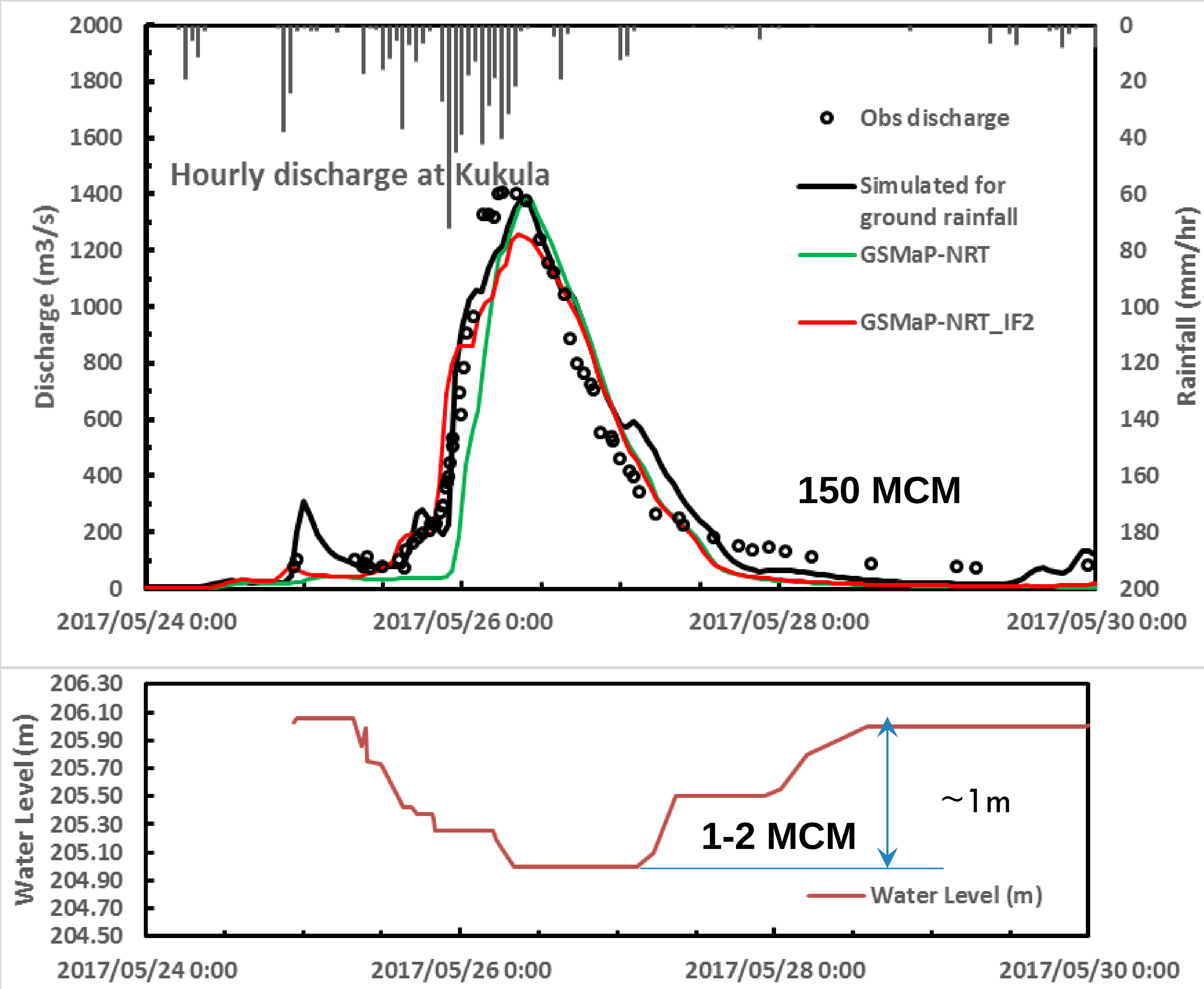
More real-time data can be incorporated from ID, DOM, NBRO

Long-term Discharge Simulation at Putupaula

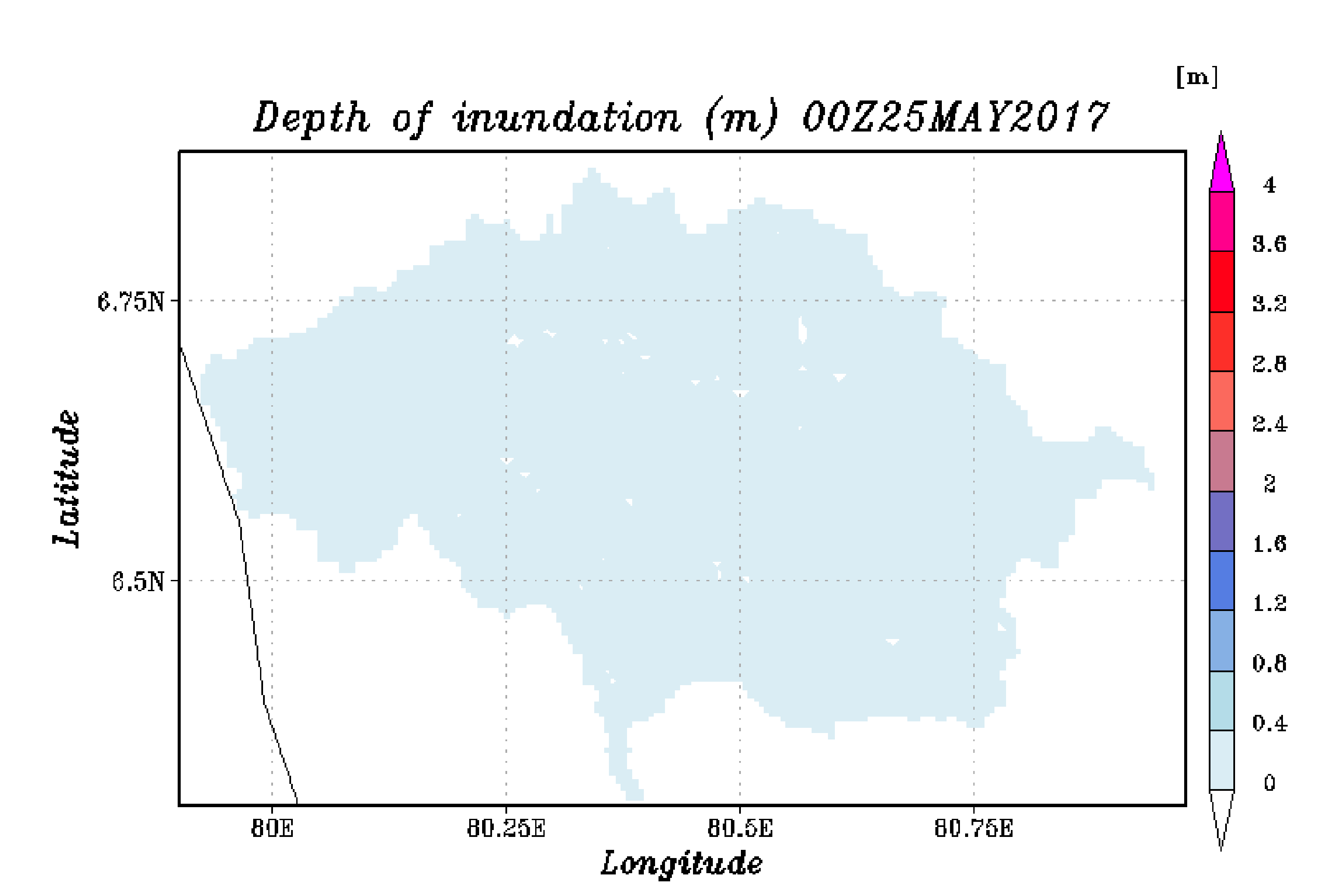




Discharge Simulation at Kukula hydro-power Station



Inundation in Kalu River simulated by RRI Model



DEM should be updated with better topographical data

Existing structures should be included for accurate river flow & inundation forecasting

Warning and evacuation for sediment disasters

Yusuke YAMAZAKI

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

Warning and evacuation for sediment disasters

Timing for evacuation and warning

Required information: relationship between the rainfall conditions and the occurrences of shallow landslide and debris flow.

Locations of safe places and paths

Required information: spatial distributions of the occurrences of shallow landslides, the runout path of debris flow and the debris fan.

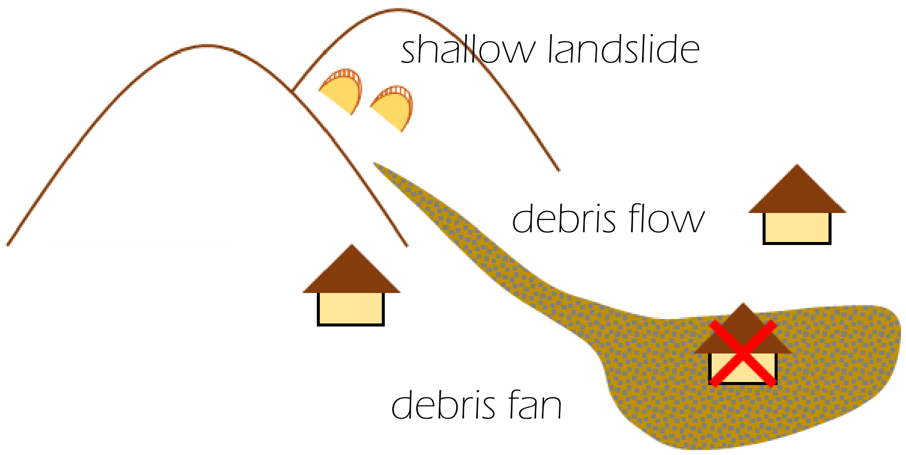


Fig. 1. Schematic view of sediment hazards

Methodology

To obtain the above information, the following methods are proposed.
One method is to predict occurrences of shallow landslides and debris flows based on stability analysis for an infinite slope, rainfalls, surface topography and soil properties.
Another method is to predict spatial distributions of sediment volume associated with debris flows based on estimation of developing and decreasing of debris flows produced by landslides.
In this presentation, the first method is introduced.

Schematic explanation and valuables of the model

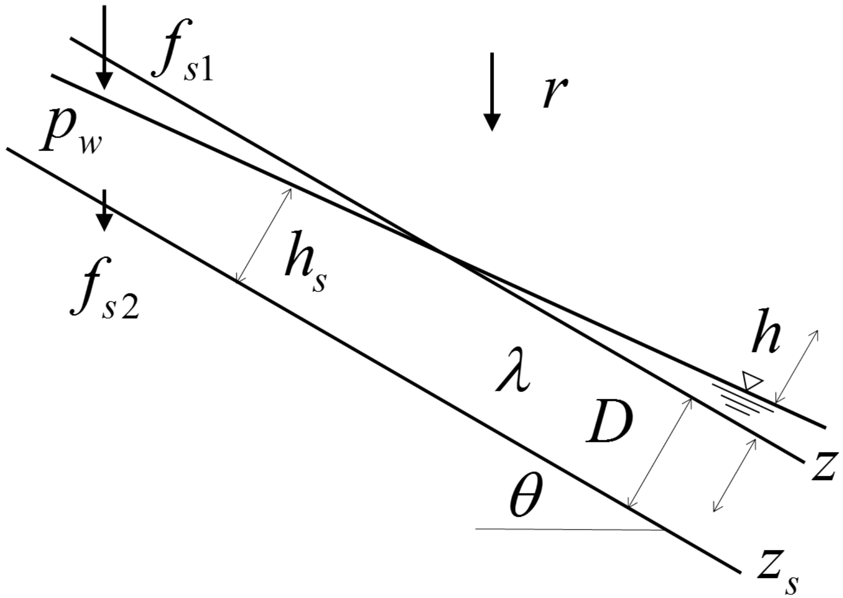


Fig. 2. Schematic explanation for surface soil layer and water surface

r: rainfall

z: elevation of surface layer

z_s: elevation of lower layer

h: depth of surface flow

h_s: depth of saturated lateral flow

f_{s1}: infiltration rate of surface layer

f_{s2}: infiltration rate of lower layer

D: depth of surface layer

λ: porosity of surface layer

p_w: water content of surface layer

Landslide occur when $\theta_c < \theta$

$$\tan\theta_c = \frac{\left(\frac{\sigma}{\rho} - \frac{h_s}{D}\right)c_* + \left(1 - \frac{h_s}{D}\right)p_w + c/(\rho g D\cos\theta\tan\phi)}{\left(\frac{\sigma}{\rho} - \frac{h_s}{D}\right)c_* + \left(1 - \frac{h_s}{D}\right)p_w + \frac{(h_s + h)}{D}}\tan\phi$$

σ: mass density of soil particles ρ: mass density of water c_*: sediment concentration

c: cohesion ϕ: interparticle friction angle

Yamazaki Y., Egashira S., and Iwami Y., Method to Develop Critical Rainfall Conditions for Occurrences of Sediment-Induced Disasters and to Identify Areas Prone to Landslides, JDR Vol.11 No.6, pp. 1103-1111, 2016

Simulated spatial distribution of shallow landslide

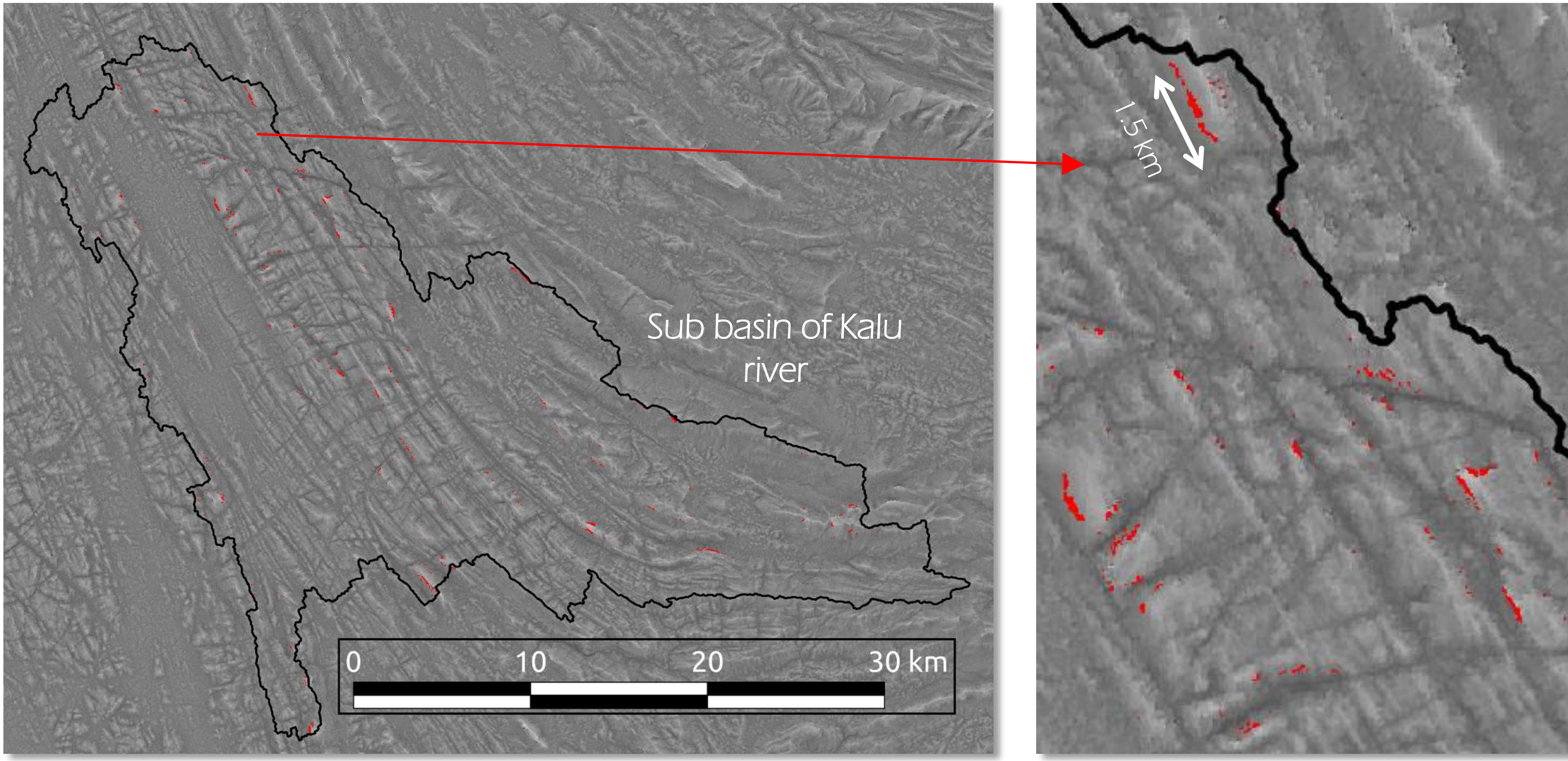


Fig. 3. *Spatial distribution of meshes estimated to occur landslides with 30m x 30m grid cells, GSMaP and general parameters*

Developing of critical rainfall condition

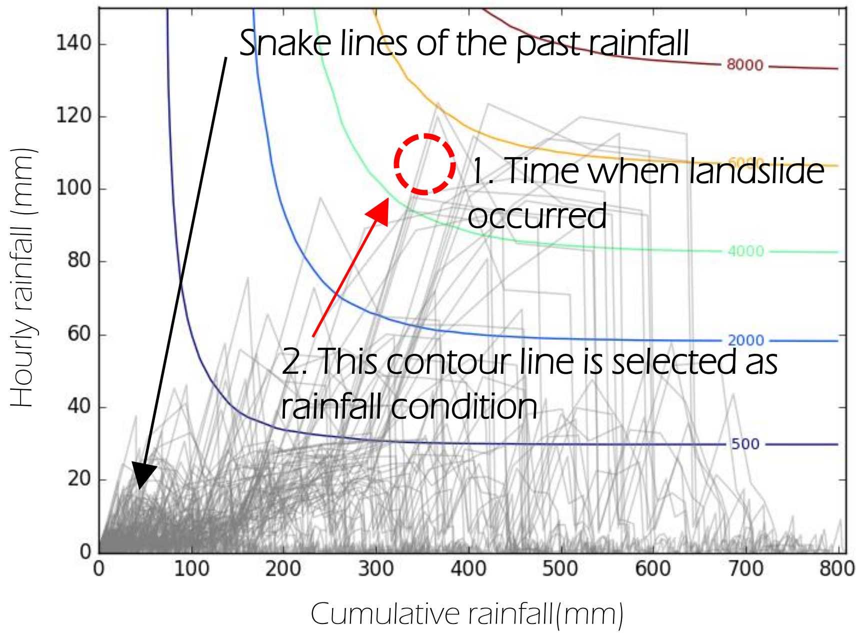


Fig. 5. Method for setting critical rainfall condition.

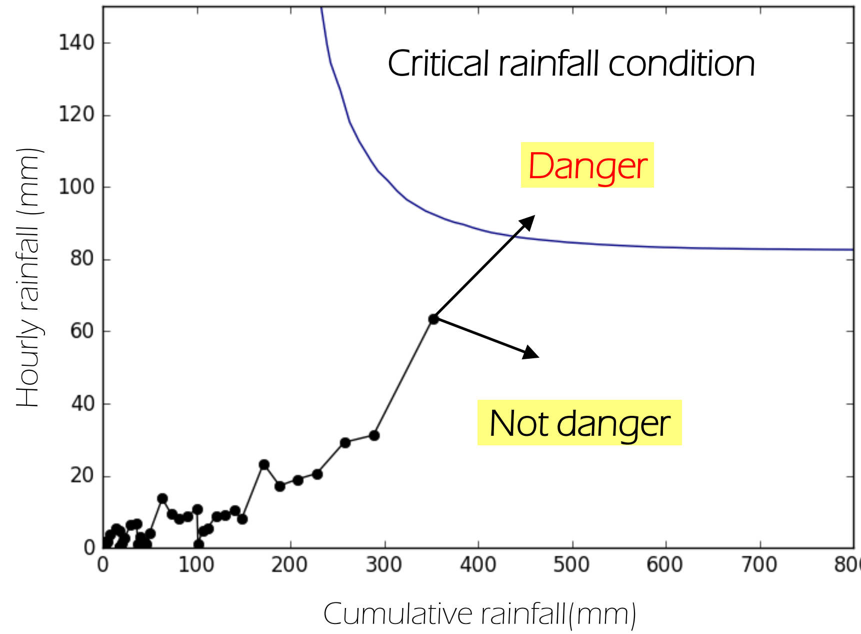


Fig. 6. Warning to evacuate based on critical rainfall condition and forecasted rainfall.

One contour line is selected as a critical rainfall condition based on the time of landslide occurrence on the snake line of the past rainfall that caused landslide. The contour lines are generated by the data obtained by simulation with various steady-state rainfall intensity.

Location, occurrence time and depth of landslide are necessary to improve accuracy of the model.

Overall Scheme on Emergency Support for Flood Management in Sri Lanka

Tetsuya IKEDA

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

What happened so far

May 24 – , 2017

Heavy rain and flood disasters occurred in Sri Lanka
Start providing the flood-related information

June 2 – 11, 2017

Government of Japan dispatched the Japan Disaster Relief (JDR) Expert Team to Sri Lanka

July 6, 2017

ICHARM of PWRI and University of Tokyo jointly issued the Press Release on the future activity in response to the flood disasters

August 23 – 24, 2017

Meeting with the related governmental organizations of Sri Lanka (DMC, NBRO, Irrigation Department, Meteorological Department, Ministry of Megapolis & WD)

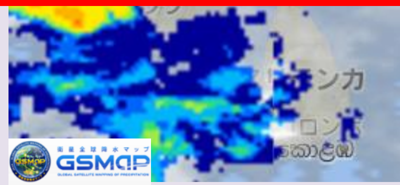
August 24, 2017 (Today)

Plenary Session with the DGs from the related organizations

Present situation: Test operation for rainy season

Implemented by EDITORIA and ICHARM on DIAS

In-situ rain gauge data (6 numbers)



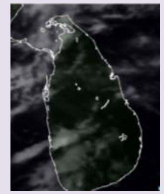
Satellite precipitation data（GSMaP）

4 hr latency data (NRT)

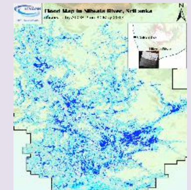
Real time data (NOW)

Calibration

Ensemble forecasting rainfall for the next 16 days (max)



Himawari-8 cloud images



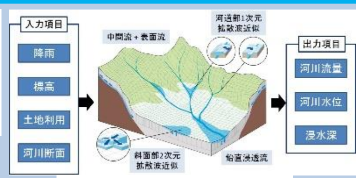
ALOS © JAXA (2016)

Inundation map by satellite data (ALOS-2)

Flood Forecasting for Sri Lanka

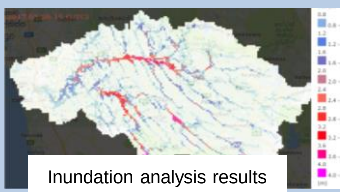
Inundation analysis by using RRI in DIAS

RRI model



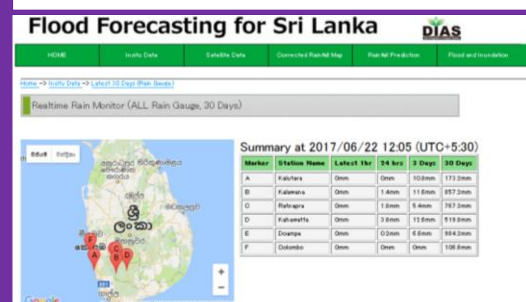
Concept of RRI model

Simulation and forecasting of river discharge, water level, inundation extent



Inundation analysis results

On-line Information provision on DIAS: In-situ rainfall, satellite rainfall, calibrated and forecast rainfall, inundation simulations



Email alert messages

Information provision

Collaboration

Sri Lanka disaster management platform

Government of Sri Lanka (Irrigation Department)

Damage reduction by pre-disaster measures

Government of Sri Lanka (Disaster Management Center)

Evacuation advisory by early warning

Mid-term framework

INTERNATIONAL FLOOD INITIATIVE

Collaboration with member organizations of disaster management platform

Capacity building for operation

Member organizations of national platform

- Meteorology Department
- Irrigation Department
- Disaster Management Center
- Universities

and others

- Promotion of research
- Damage reduction through implementation

Future Planning

August 24 – , 2017 (From now on)

Soon after this Plenary Session, Start "Test Operation (focus on rainfall monitoring and prediction)" to utilize the flood information by Sri Lankan side with assistance from ICHARM

August 28 – 30, 2017

Training course on RRI Modeling for the engineers from Irrigation Department, under the JAXA-SAFE (*) Project

(*) The Space Applications for Environment

Follow-up

- Collaborative works for system improvement (Inundation prediction and Landslide prediction)
- Providing the technical support and conducting the training/ capacity development by ICHARM, if necessary
- Review of the Test Operation

Until the beginning of the next flood season (May 2018 –)

Improvement for Better Flood Management in Sri Lanka

Thank you vey much for your attention

E-mail: icharm@pwri.go.jp
URL: http://www.icharm.pwri.go.jp