Flood Forecasting for flood disaster reduction
- ICHARM activities related to MAHASRI -

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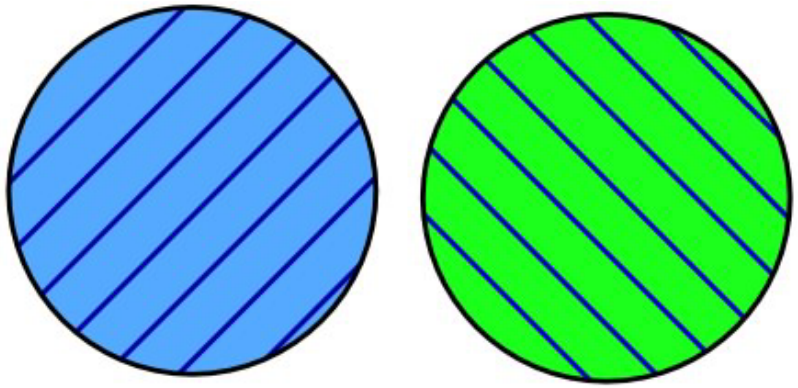
Floods

- Seasonal (riverine) flood
  ← monsoon rainfall, snowmelt, etc.
- Flash flood
  ← heavy short-term storm, snowmelt, etc.

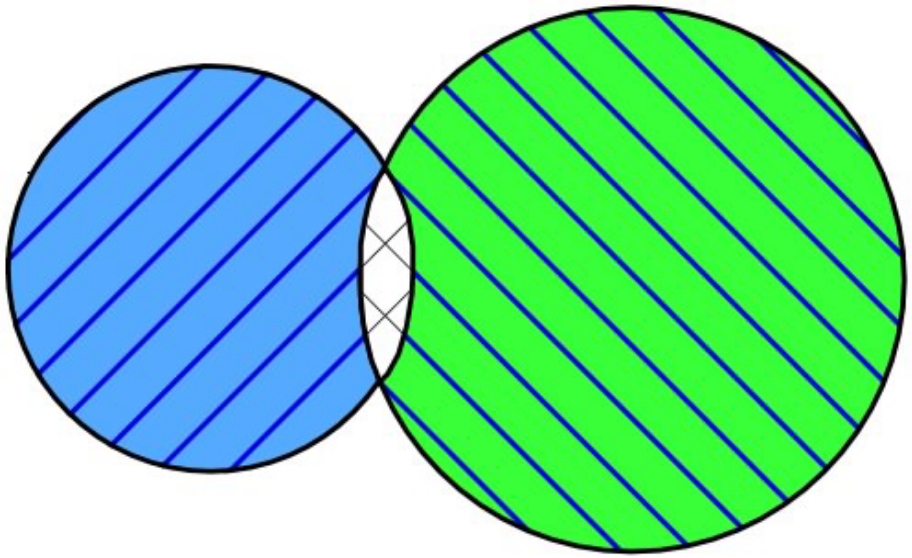
- ◆Urban flood
- ◆Debris & mud flow (often as a flash flood)
- ■ Snowmelt flood
- ■ Ice jam flood
- ■ Glacier lake outburst flood
- ■ Dam-break flood

Hazard and Risk (Disaster)



HAZARDS VULUNERABILITY

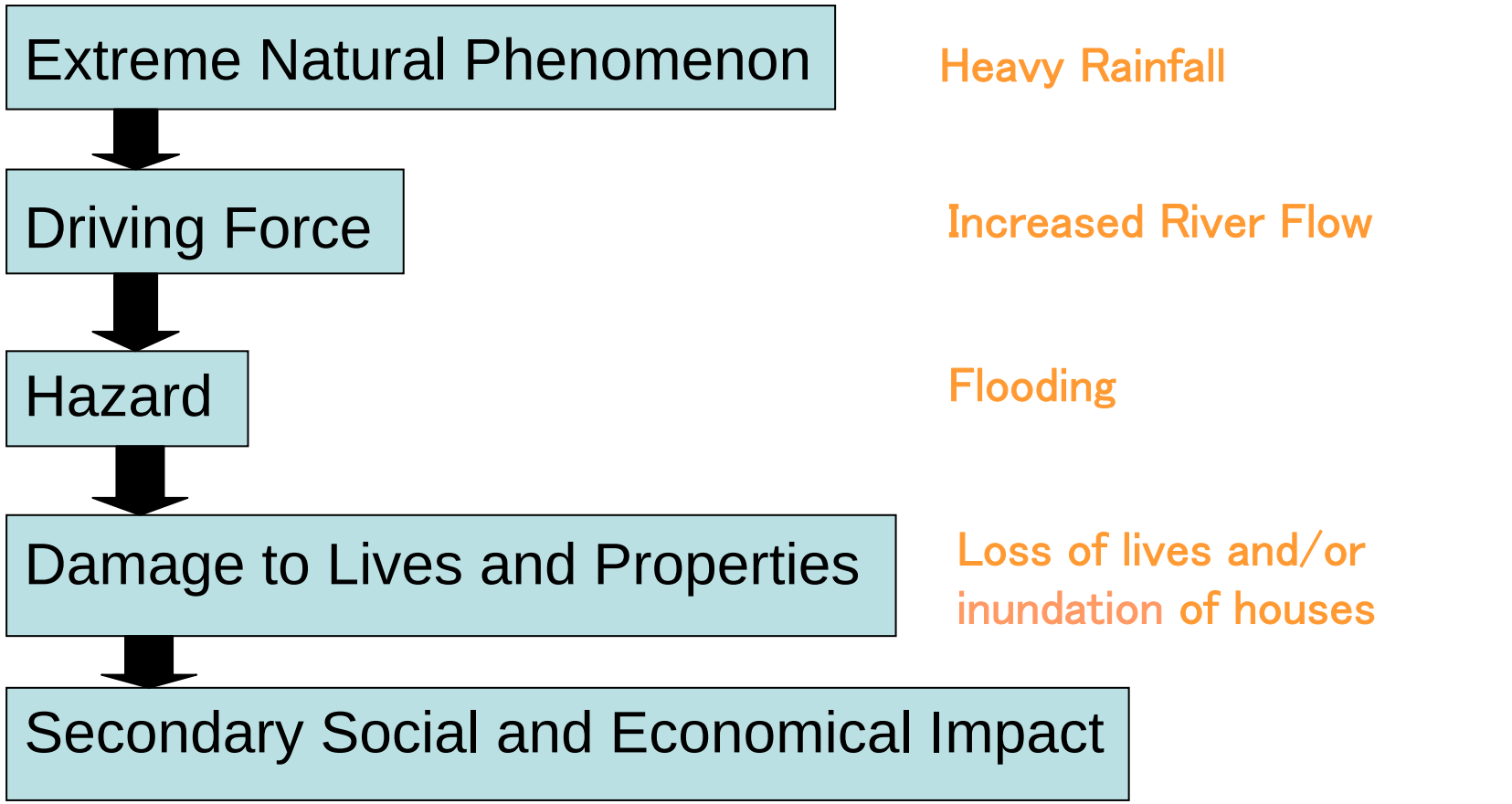
No Risk



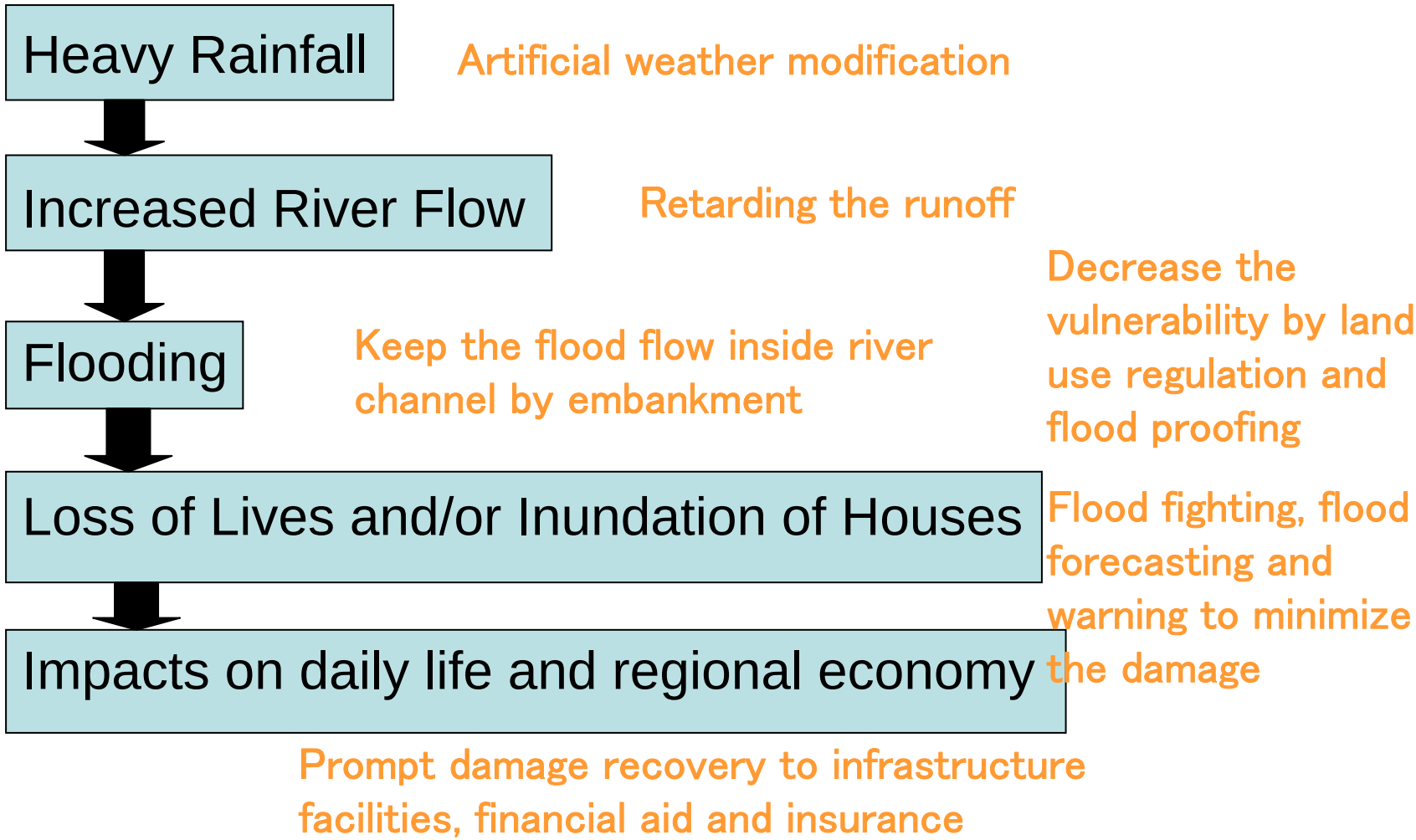
HAZARD∩ VULUNERABILITY = DISASTER

Disaster

Process Chain of Natural Disasters



Flood Risk Management to cut Process Chain of Flood Disasters



Flood Risk Management

- Structural (Engineered and non-engineered works)
  - Construction of dams and river embankments (levy)
  - River improvement works, floodway, flood (stormwater) retarding basin, etc.
  - Slope protection (Sabo = erosion control)
  - High-floored houses, shelters, riverside forests and bamboos, etc. (non-engineered)
- Non-structural
  - Legal framework, coordination among stakeholders
  - Land use (spatial) management
  - flood monitoring, forecasting & early warning systems
  - Preparedness –hazard mapping, improving communication, education to create awareness
  - Insurance and mutual aid

Issues for flood monitoring and forecasting

- How to monitor and forecast areal rainfall (or snowpack/glacier) in the upstream?
- How to build a flood runoff model for a basin?
- How to identify the flood disaster risk?
- How to disseminate the flood warning?
- How to react to the warning for the disaster mitigation?

Importance of flood monitoring (Experiences in Japan)

- ～1950’s: Community-based manual observation
- 1960’s～: Recording raingauge & water level gauge, and microwave telemetry network system

Real-time & accurate grasp of flood situation in the upstream

Immediate decision & action for flood fighting

Possible topics of MAHASRI for the improvement of flood forecasting

- To understand temporal & spatial characteristics of rainfall (snowfall, snowpack or glacier) and its extreme events, including frequency analysis
- To suitably monitor and forecast them
  - ex.) Requirement of ground data, radar/satellite-based rainfall estimation, restoration of historical data, etc.
  - ex.) Improvement of rainfall forecasting with non-hydrostatic numerical weather forecast model using the data downscaled from global/regional weather forecast data
- To suitably model the flood runoff with available database
  - ex.) Development of GIS-based distributed hydrologic and hydraulic models and the understanding of the characteristics of the models
- To suitably disseminate the flood warning to people at flood risk

Current research activities and future subjects at PWRI/ICHARM in relation to flood forecasting

1. Development of satellite-based global real-time rainfall map for flood forecasting and warning on a river basin scale (with JAXA and CREST/GSMaP group)
2. Development of rainfall forecasting system for ungauged basins (with UCD)
3. Development of a common basis for quick & efficient implementations of flood forecasting and warning systems even in poorly-gauged basins (with private sectors)
4. Development of a guideline for flood warning dissemination to meet local flood-plain needs in different natural/social/monitoring
5. Development of a guideline for integrated flood management combined with other structural & non-structural measures

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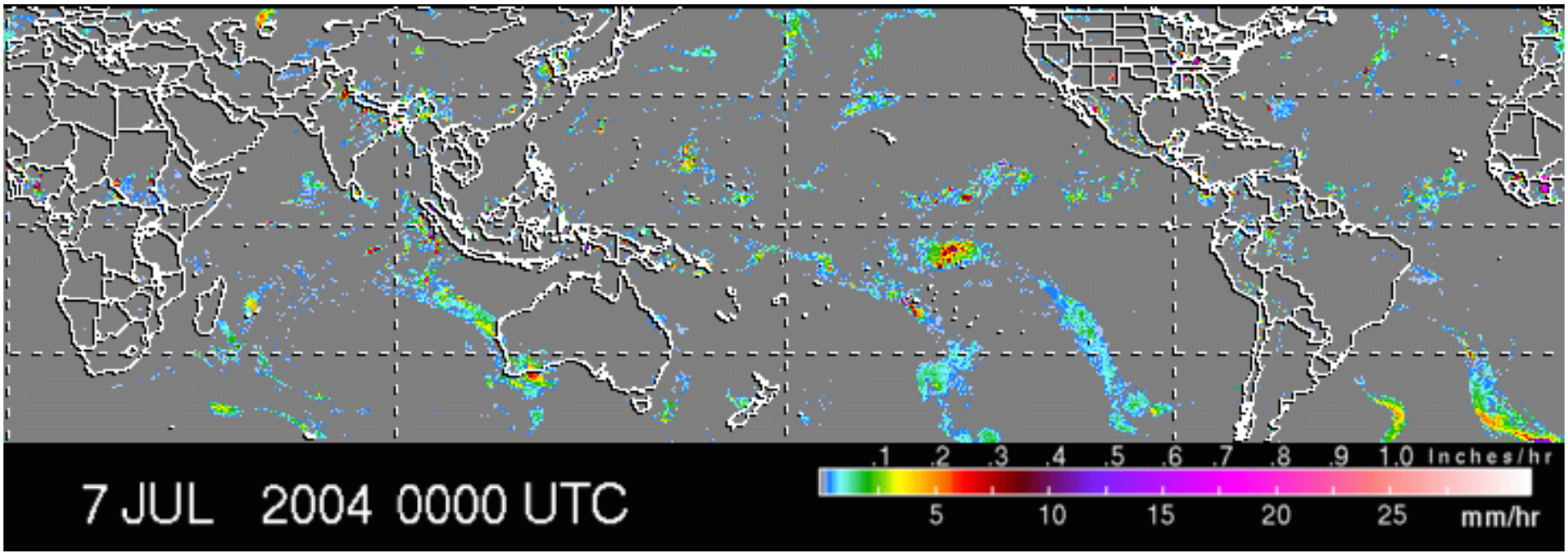
Examples of global products of satellite-derived precipitation

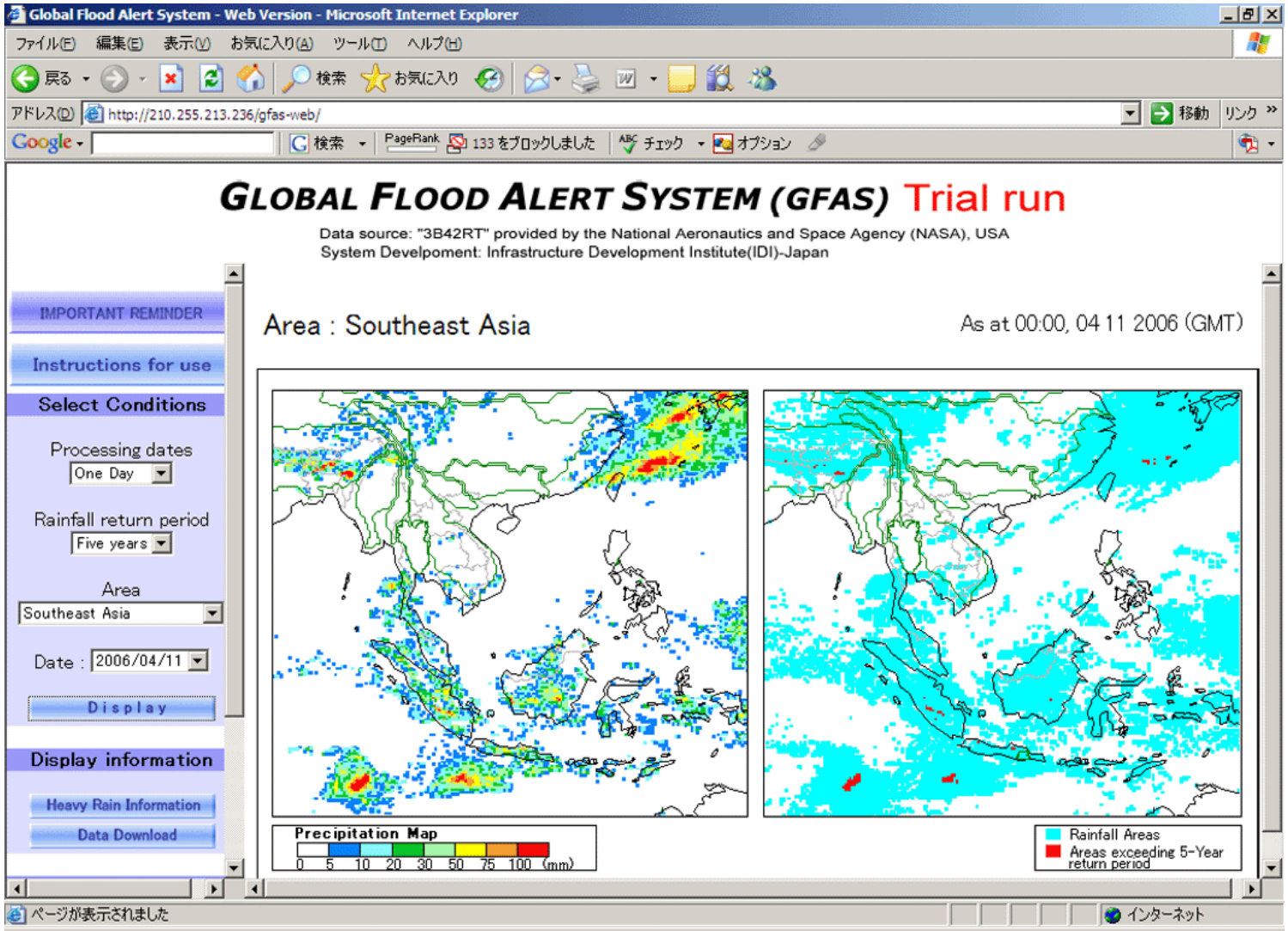
Product name	**3B42RT**	**CMORPH**			
Builder	NASA/GSFC	NOAA/CPC			
Coverage	50N～50S	60N～60S			
Spatial resol.	0.25˚	8km	0.25˚	0.25˚	0.5˚
Temporal resolution	3 hours	30 minutes	3 hours	1 day	3hours
Delay of data delivery	10 hours	15 hours			
Timing of data updating	Every 3 hours （UTC）	Every 30 min. （UTC）	Every 3 hours （UTC）	Every one day （UTC）	Every 3 hours （UTC）
Coordinate system	WGS				
Data archive	Dec. 1997 ～	Recent 4 days	Dec. 2002 ～	Jan. 2004 ～	Dec. 2002 ～
Data source	TRMM-TMI, DMSP-SSM/I, Aqua-AMSR-E, AMSU-B and IR	DMSP-SSM/I, TRMM-TMI, Aqua-AMSU-B, and IR			

Example of satellite-based rainfall product

- 3B42RT (NASA)
  - Temporal resolution: 3hr (snap shot)
  - Spatial resolution: 0.25 deg. ~ 25km



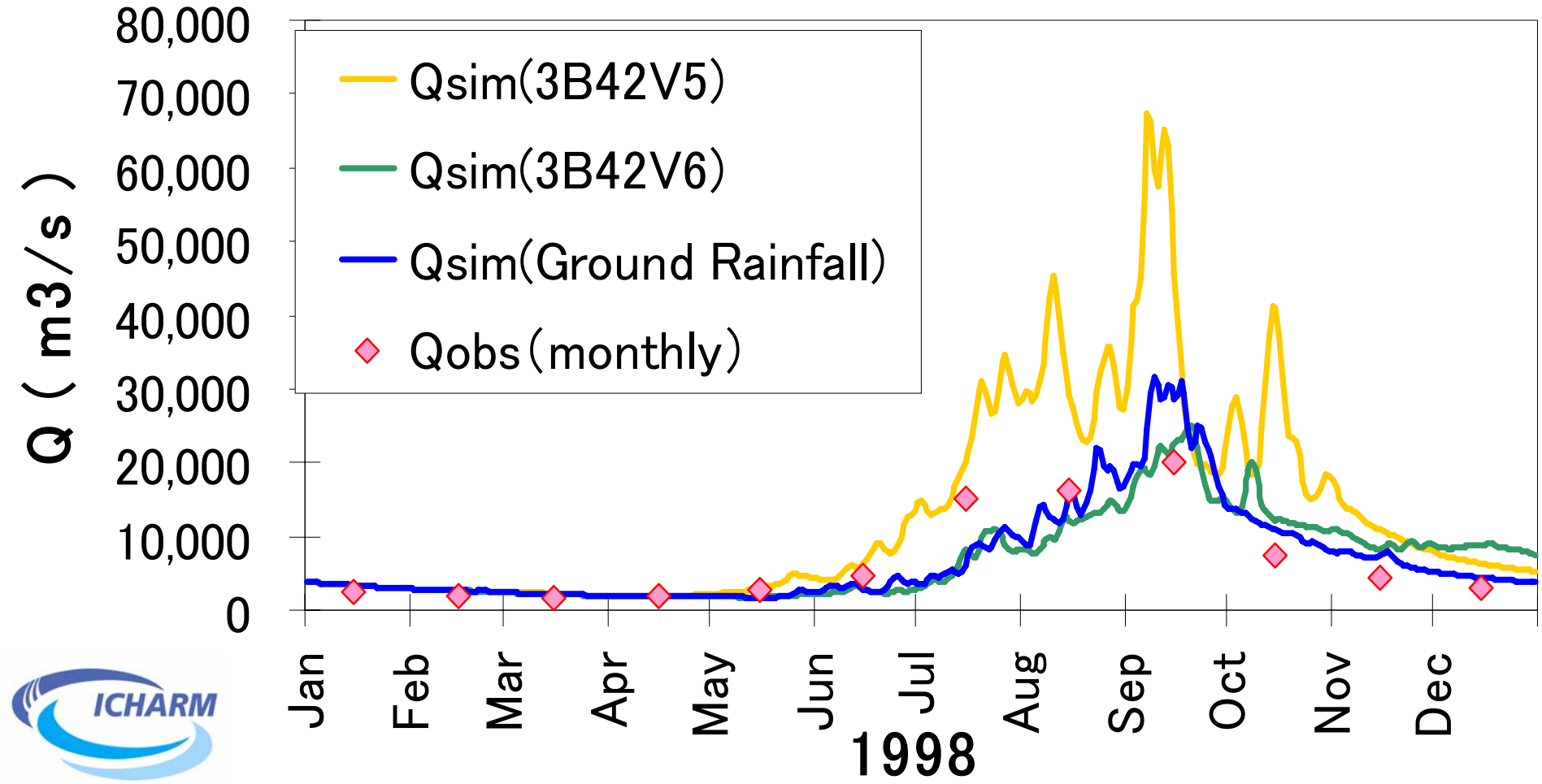
Global Flood Alert System (GFAS)



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

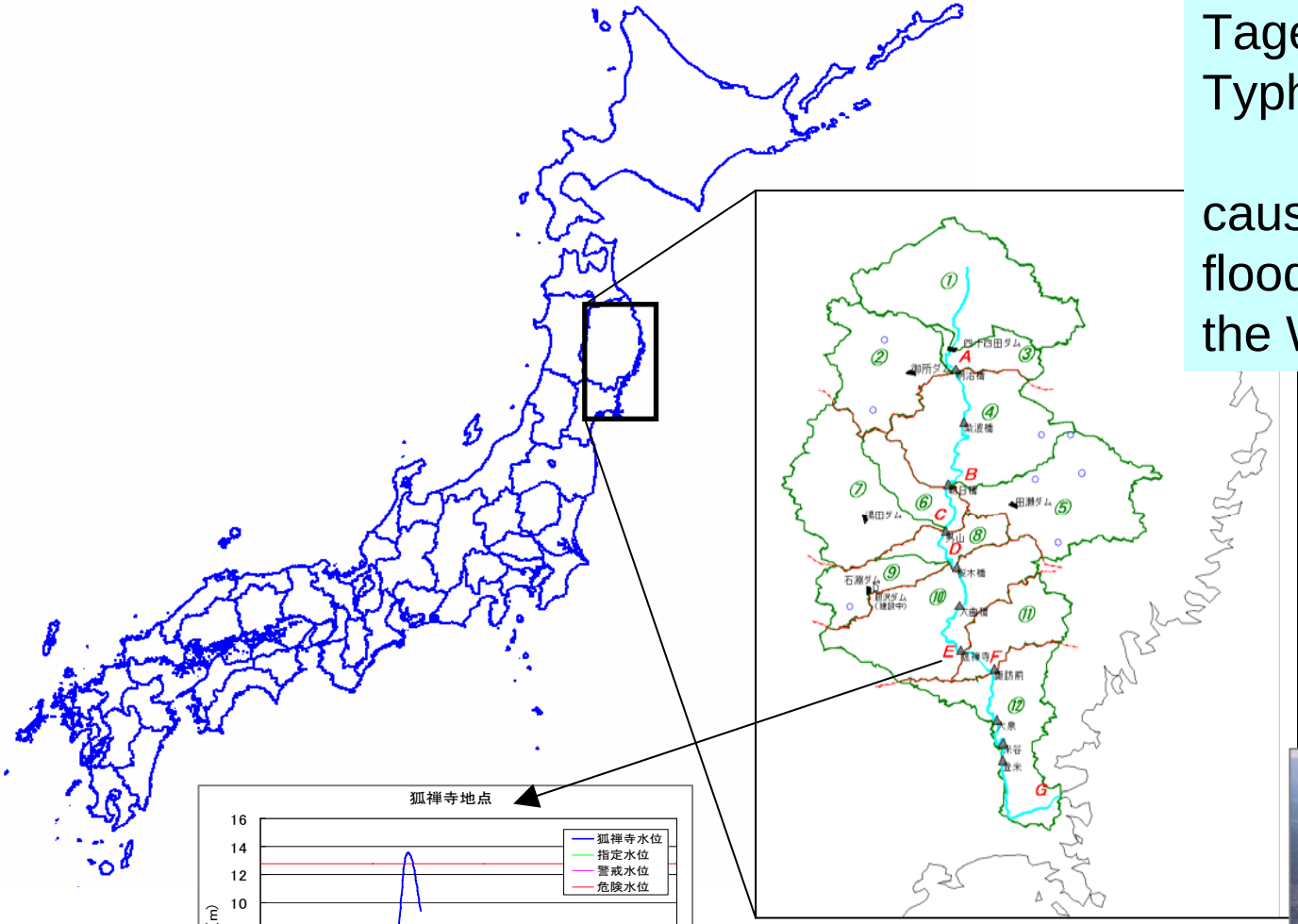
Example of runoff simulation with satellite-derived rainfall data

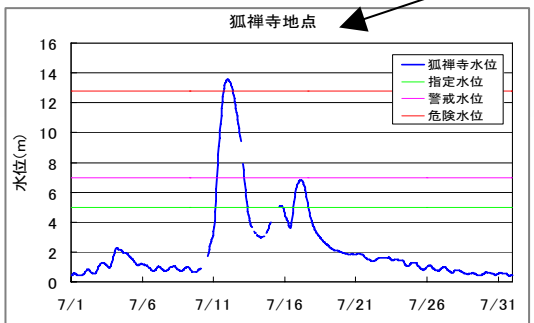
- Pakse, Mekong River (A=545,000km^2(GRDC))
- Hydrologic model:
  BTOPMC model developed by Yamanashi Univ., Japan



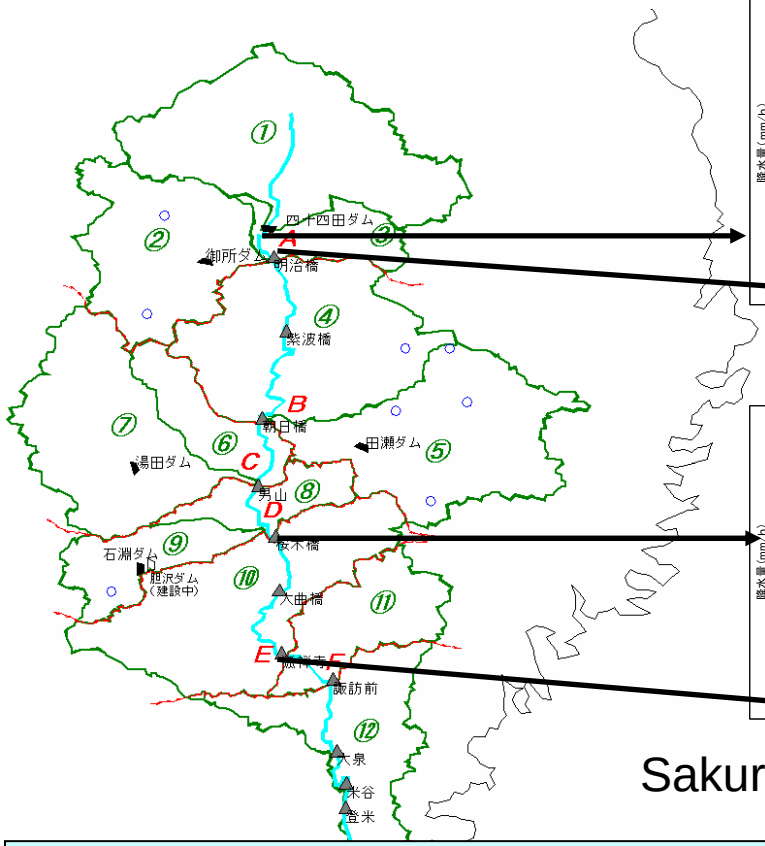
Another case study in the Kitakami-Gawa River in Japan (A=8,300km^2)

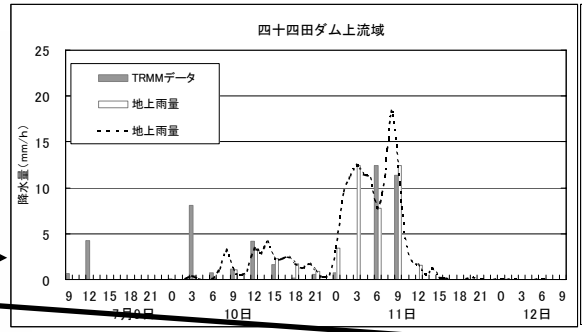
Taget event:
Typhoon No.6,
9-12 July, 2002
causing the 3rd biggest flood for the basin after the World War II

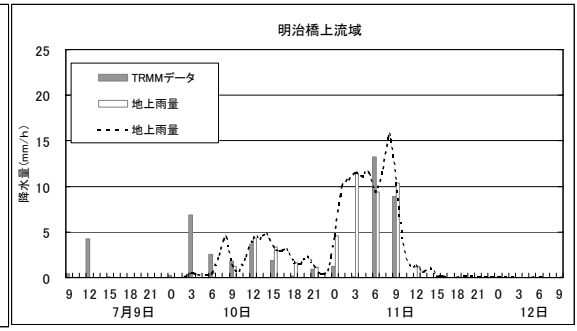




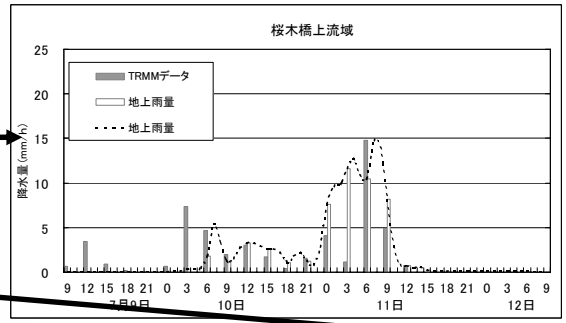
Verification of Spatially-Averaged Areal Rainfall with Satellite-Based Rainfall Product (3B42RT, T0206)

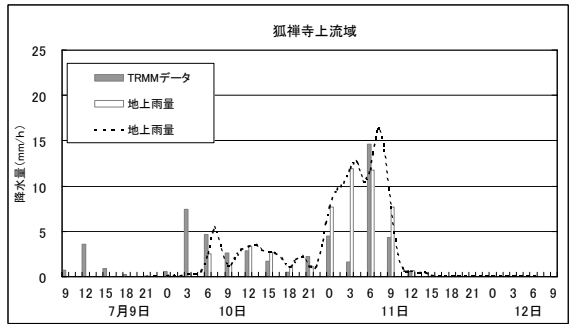






Shijushita B. (1,200km2)　Meiji-bashi B. (2,200km2)

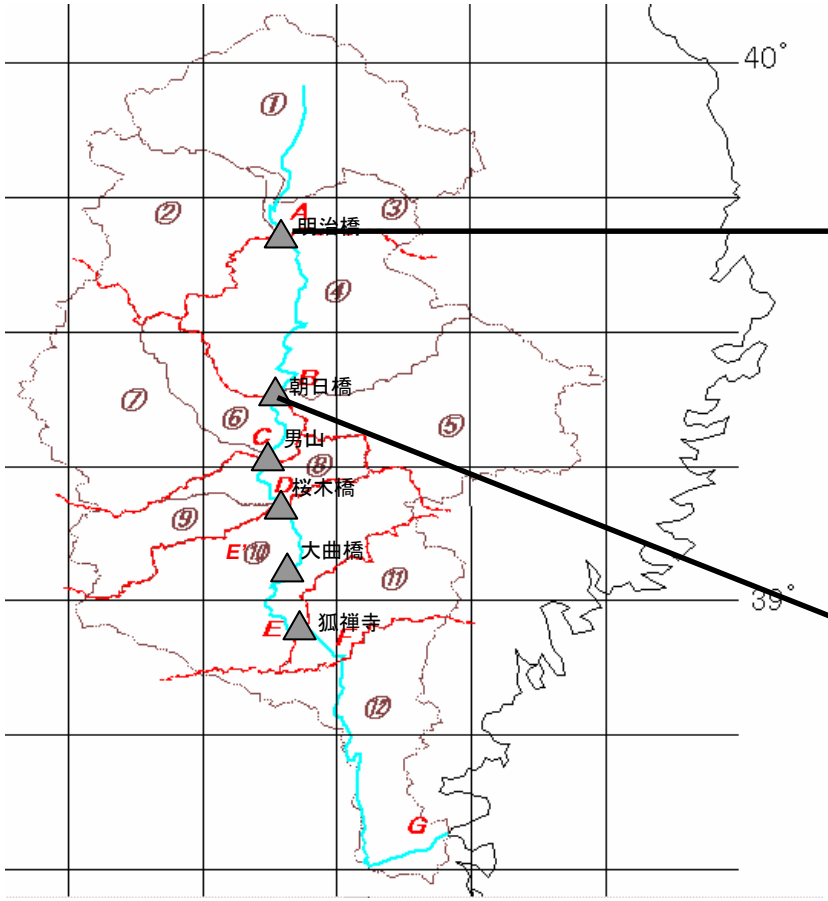


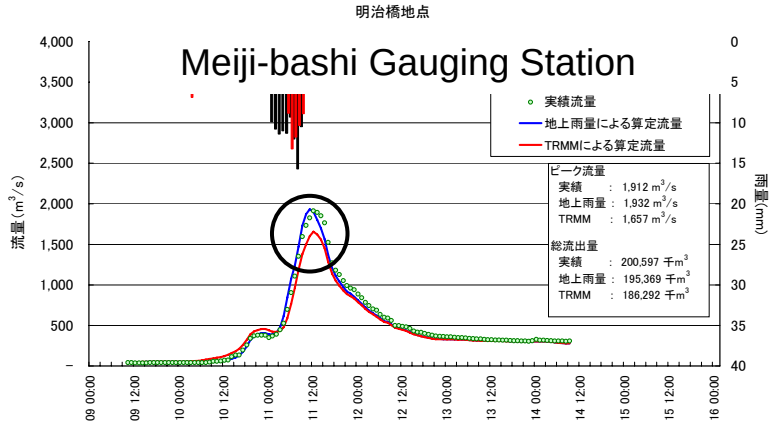


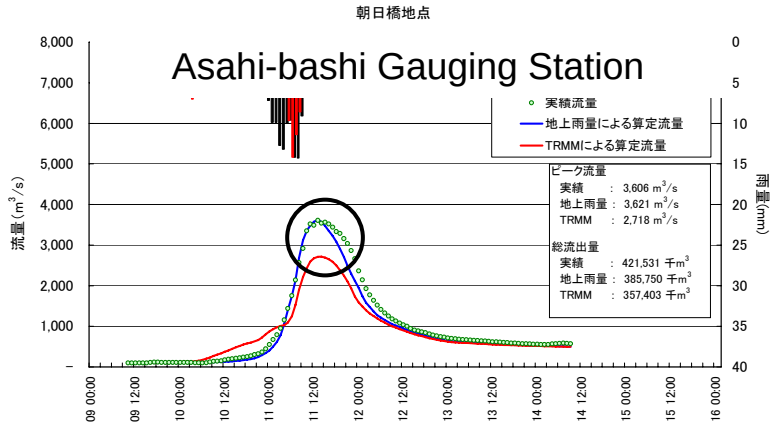
Sakuragi-bashi B. (6,000km2)　Kozenji B. (7,100km2)

- **Over-estimation in the beginning of the rainfall event**
- **Under-estimation around the peak of the rainfall event**
- **Smaller difference for total areal rainfall data of the event based on ground rainfall data**
- **Difference becomes smaller in the cases with longer for the accumulation of areal rainfall**

Verification of applicability of satellite-based rainfall for flood-runoff analysis







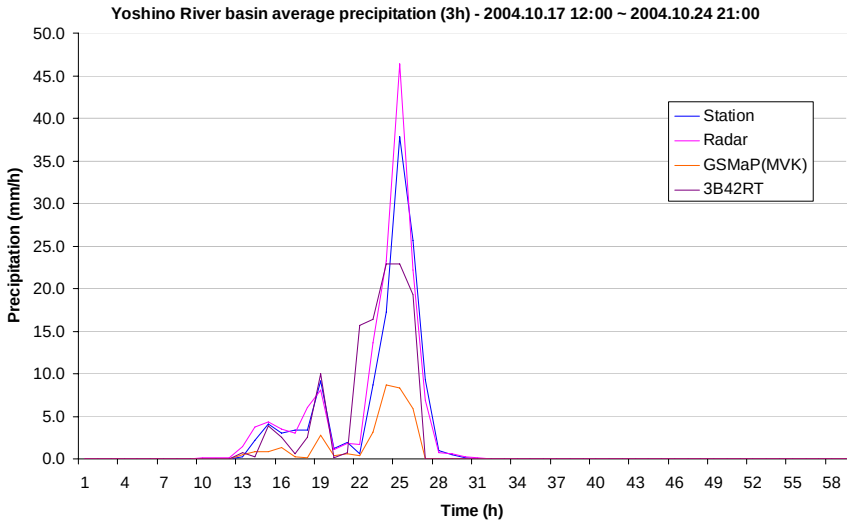
Peak discharges are under-estimated from around 10 to 25%. (dH=0.3-0.8m)
Estimation of arrival time of flood peaks are consistent with real situations.
Errors of total discharges for this event are almost smaller than those of peaks.

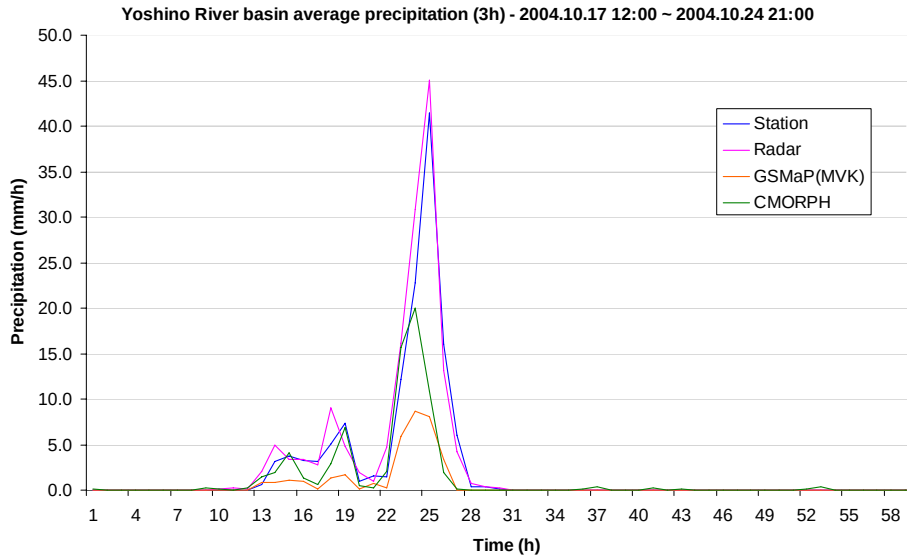
JAXA-PWRI Cooperative Research

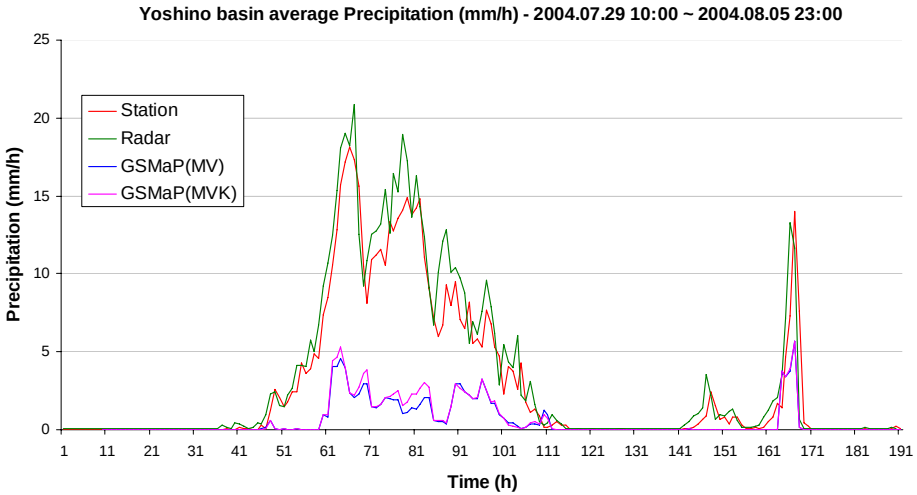
- Title: Study on the improvement of the accuracy of satellite-derived rainfall estimation for flood forecasting and its applications under GPM

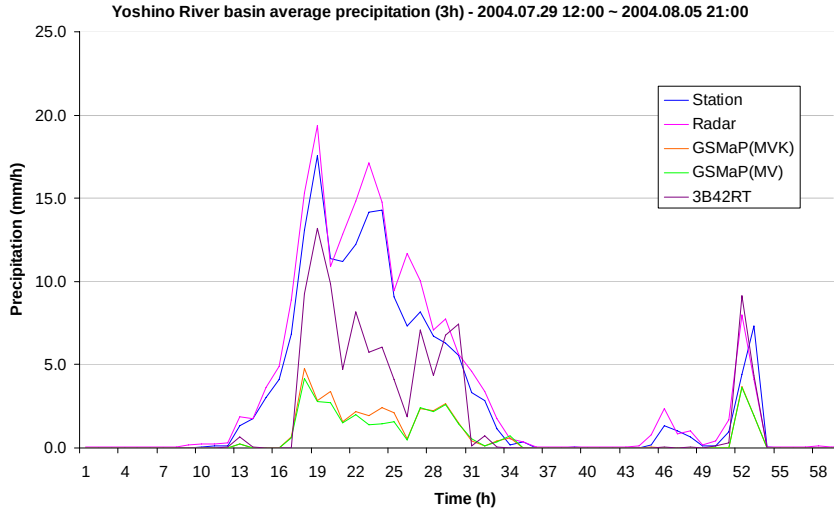
- Target:
  - Time resolution: 1hr
  - Spatial resolution: 10km
  - Improvement of rainfall estimation and forecast over land area

Preliminary Result at Yoshino-gawa River Basin in Shikoku, Japan









A computer software package specifically for flood runoff analyses with GUI using not only ground-based but also satellite-based rainfall data

"*Integrated Flood Analysis System (IFAS)*"

being developed by

Joint research (FY2005-2006) among

ICHARM/PWRI, Infrastructure Development Institute (IDI),

and nine major civil-engineering consulting companies, i.e.,

CTI Engineering Co.,Ltd, NIKKEN Consultants,Inc.,
Yachiyo Engineering Co.,Ltd., Pacific Consultants Co.,Ltd.,
Tokyo Construction Consultants Co.,Ltd., NEWJEC Inc.,
Nippon Koei Co.,Ltd., CTI Engineering International Co.,Ltd.,
& Kokusai Kogyo Co.,Ltd.

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Design concept of IFAS

- Availability in poorly-gauged basins
  - Utilization of not only ground-based but also satellite-based rainfall data
  - A default flood runoff calculation model with globally-available GIS
- User-friendly graphical interfaces for data input, analysis & output, but small & light by focusing on flood forecasting and runoff analyses
- Easy & flexible maintenance and upgrade of runoff calculation models
  - A default rainfall-runoff model will be prepared, but any model more suitable for each region can replace it and utilize the common interfaces.
- Distribution of executables, free of charge (plan)

Requirements of flood runoff calculation model for IFAS

- Wide availability in the world
  - Data requirement, performance
- Availability of default parameter set
  - Linkage with GIS
- Stability of parameters with temporal and spatial scale
- Easy to apply to real river watersheds and flood forecasting there
  - Light model
- Free right for the developers (the joint research group) to use, modify and distribute

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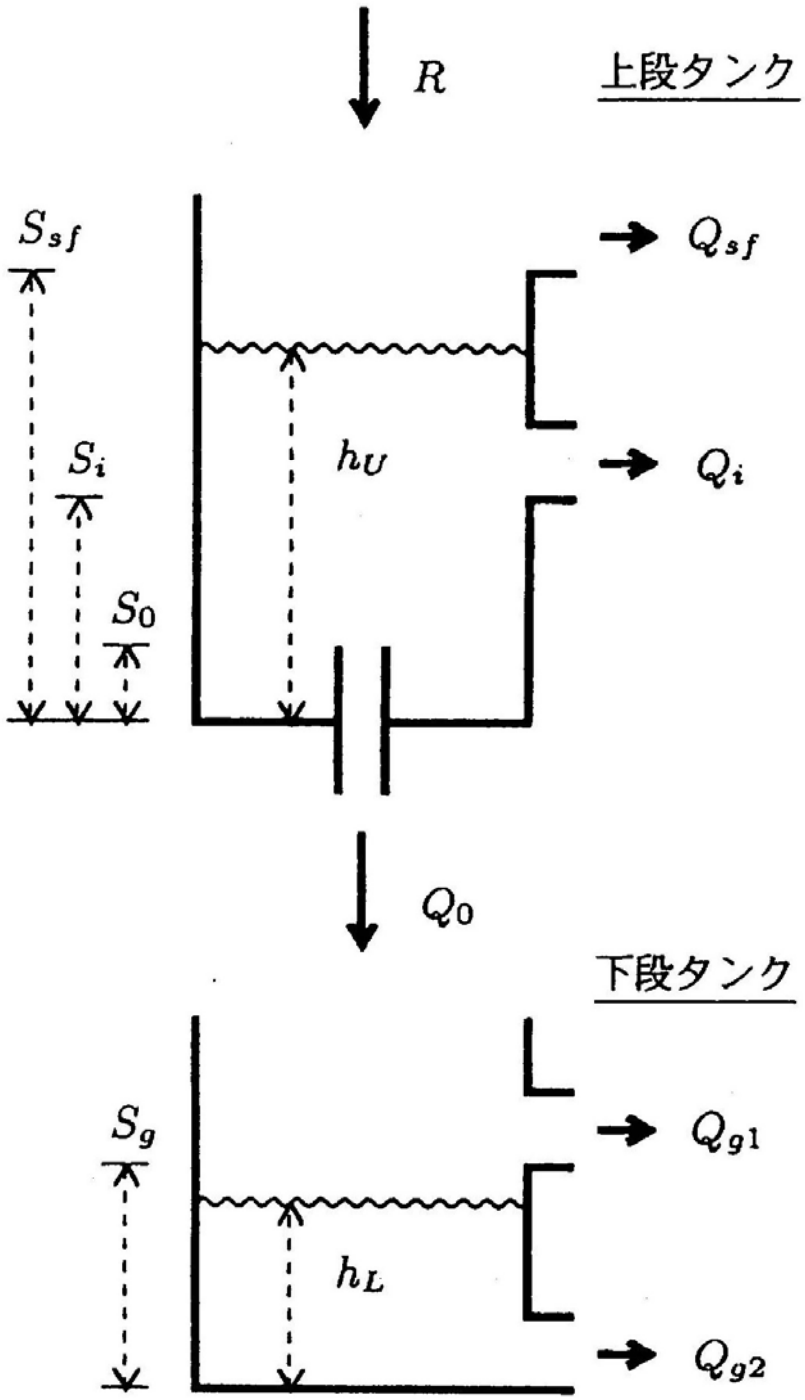

PWRI Conceptual Distributed-Parameter Hydrologic Model (PDHM, Ver.2) by Suzuki et al.(1996)

Upper tank:

Qsf: surface runoff (Manning eq.)

Qi: subsurface runoff (Darcy)

Qo: percolation (Darcy)

Lower tank:

Qg1: Unconfined groundwater runoff

Qg2: Confined groundwater runoff

River routing:

Kinematic-wave method

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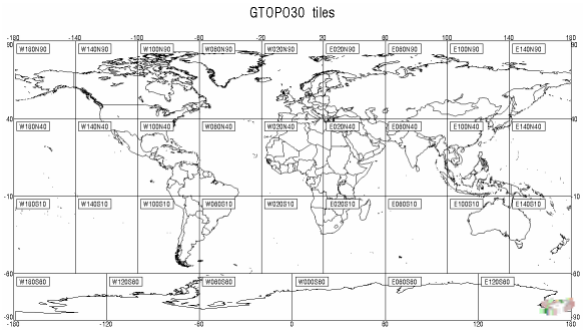
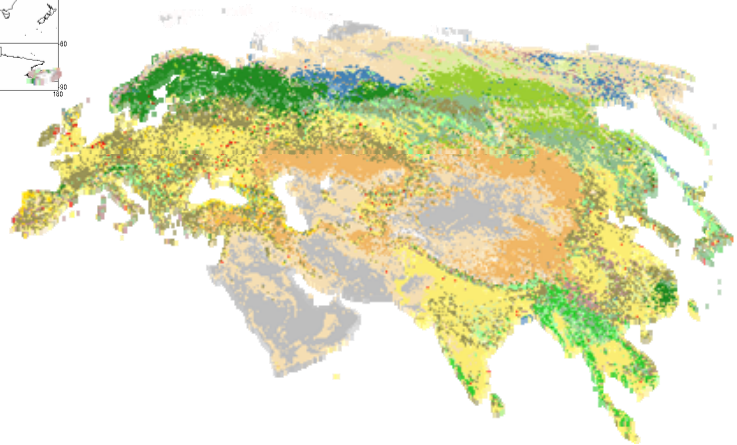
Global GIS for parameterization of runoff model

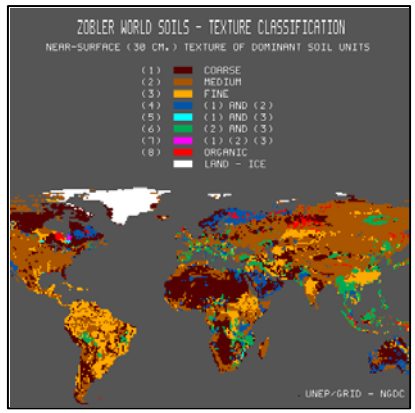
1. Topography: USGS-GTOPO30



2. Land use: USGS-GLCC

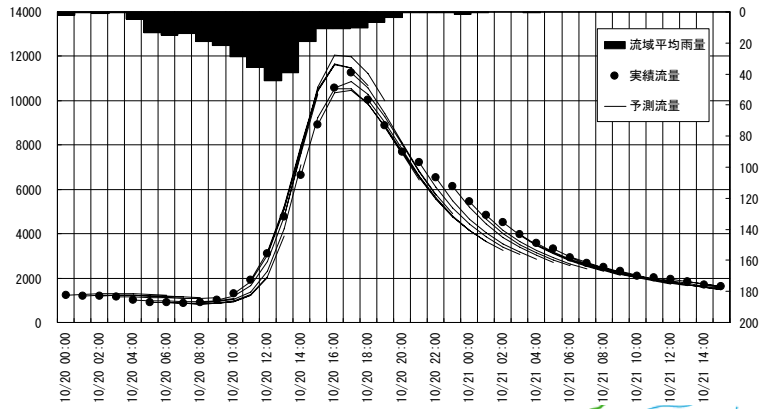


3. Soil texture: UNEP-DEWA/GRID

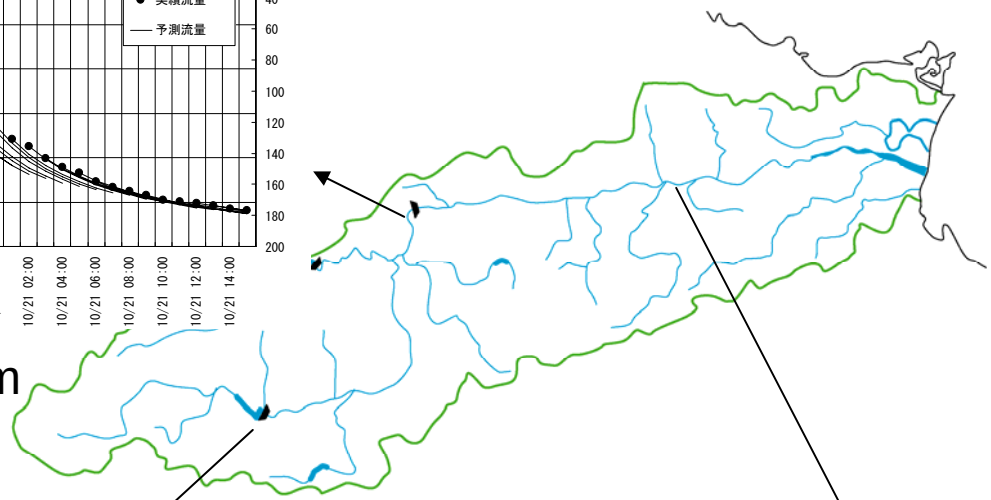


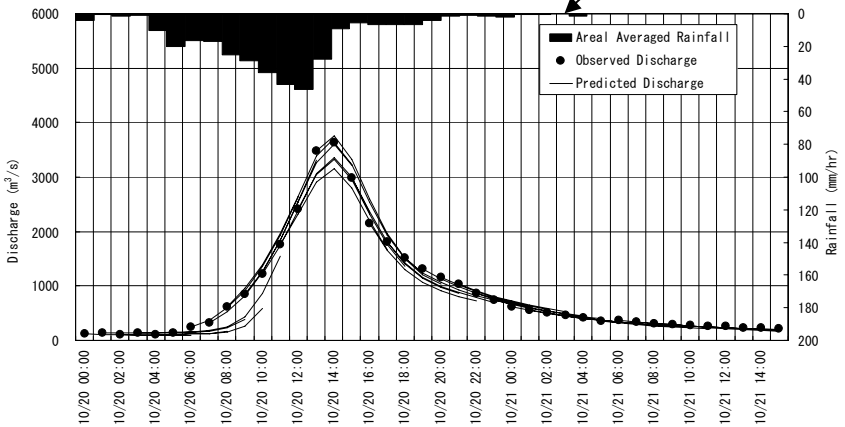
PWRI-distributed model foracasting performance

Yoshino River Basin

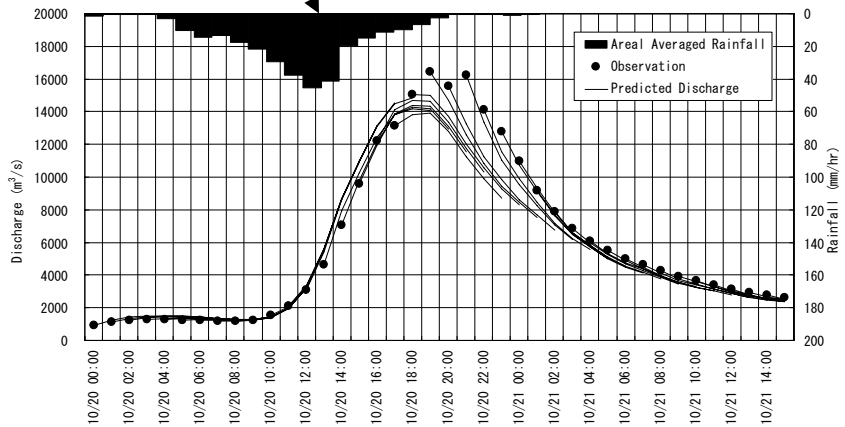


Ikeda Dam



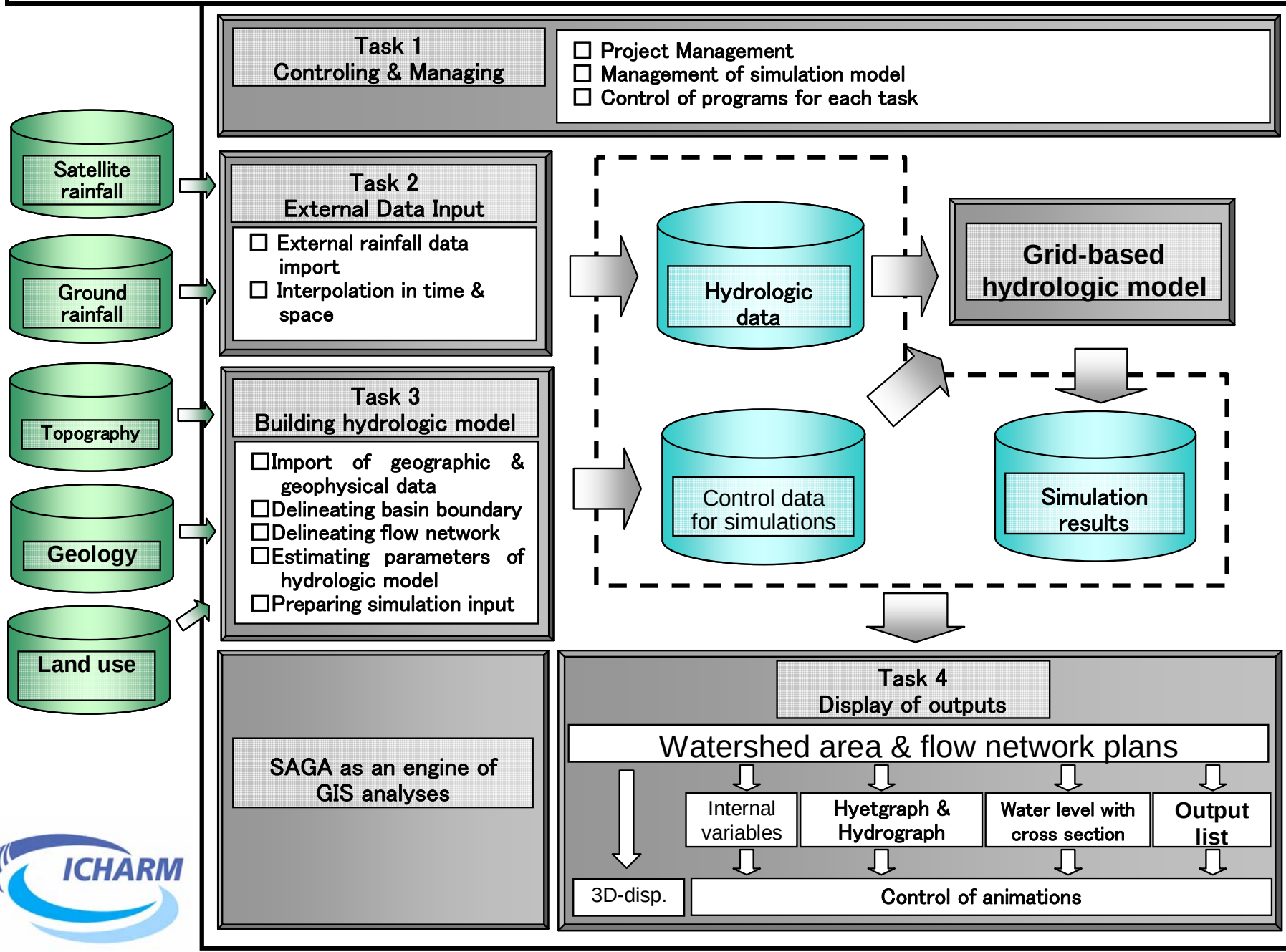


Sameura Dam

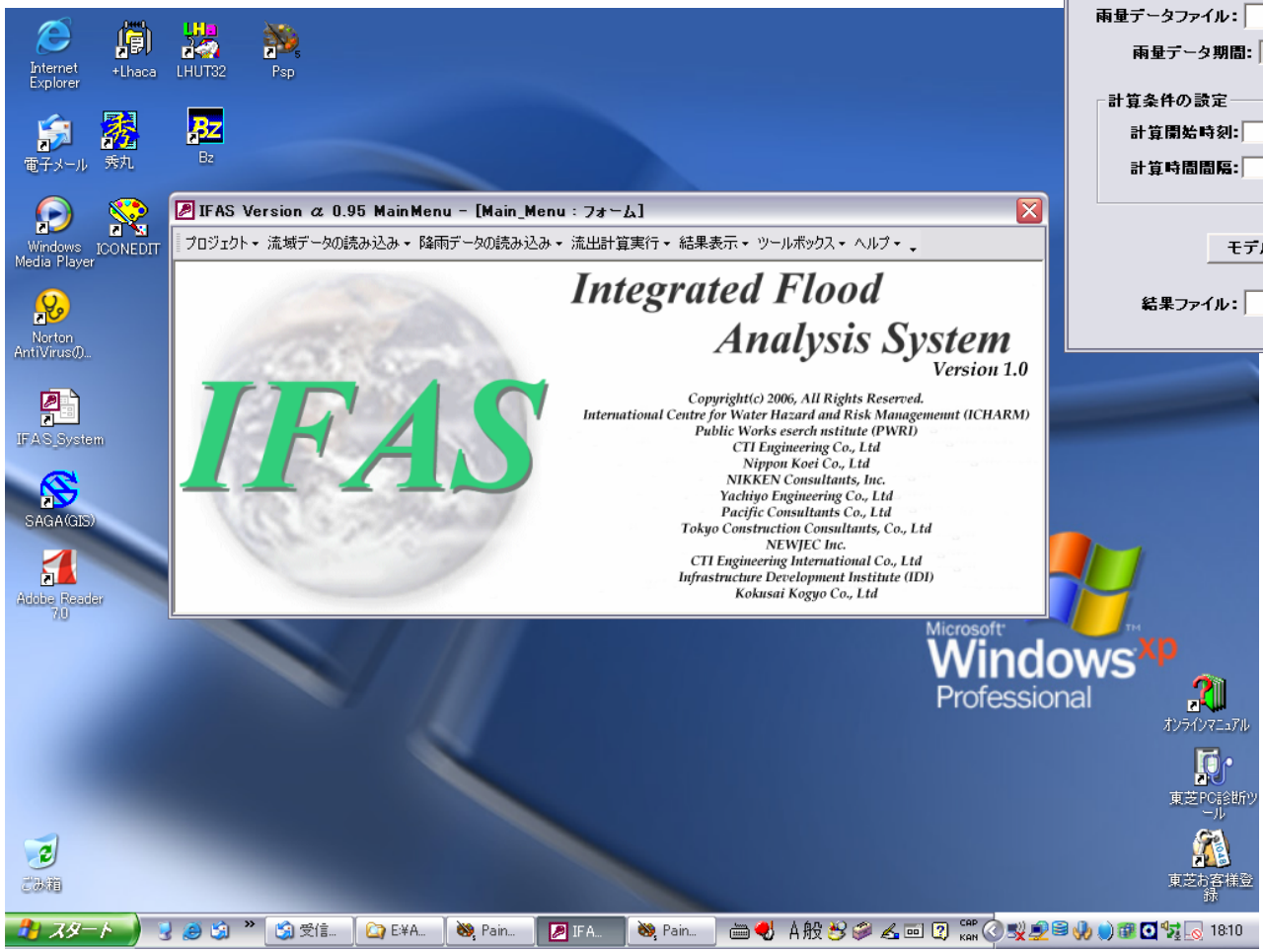


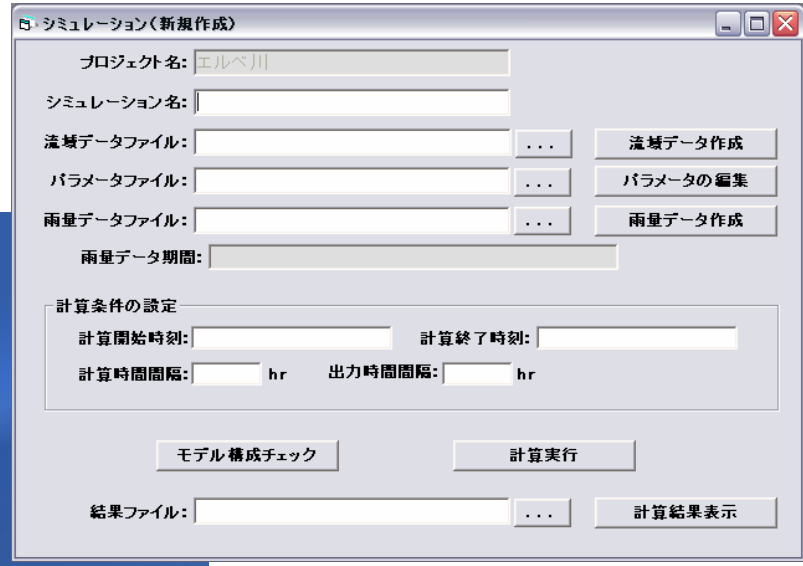
Iwazu

Structure of Integrated Flood Analysis System (IFAS)



System control & management (Task 1)





As of alpha-version, August 2006

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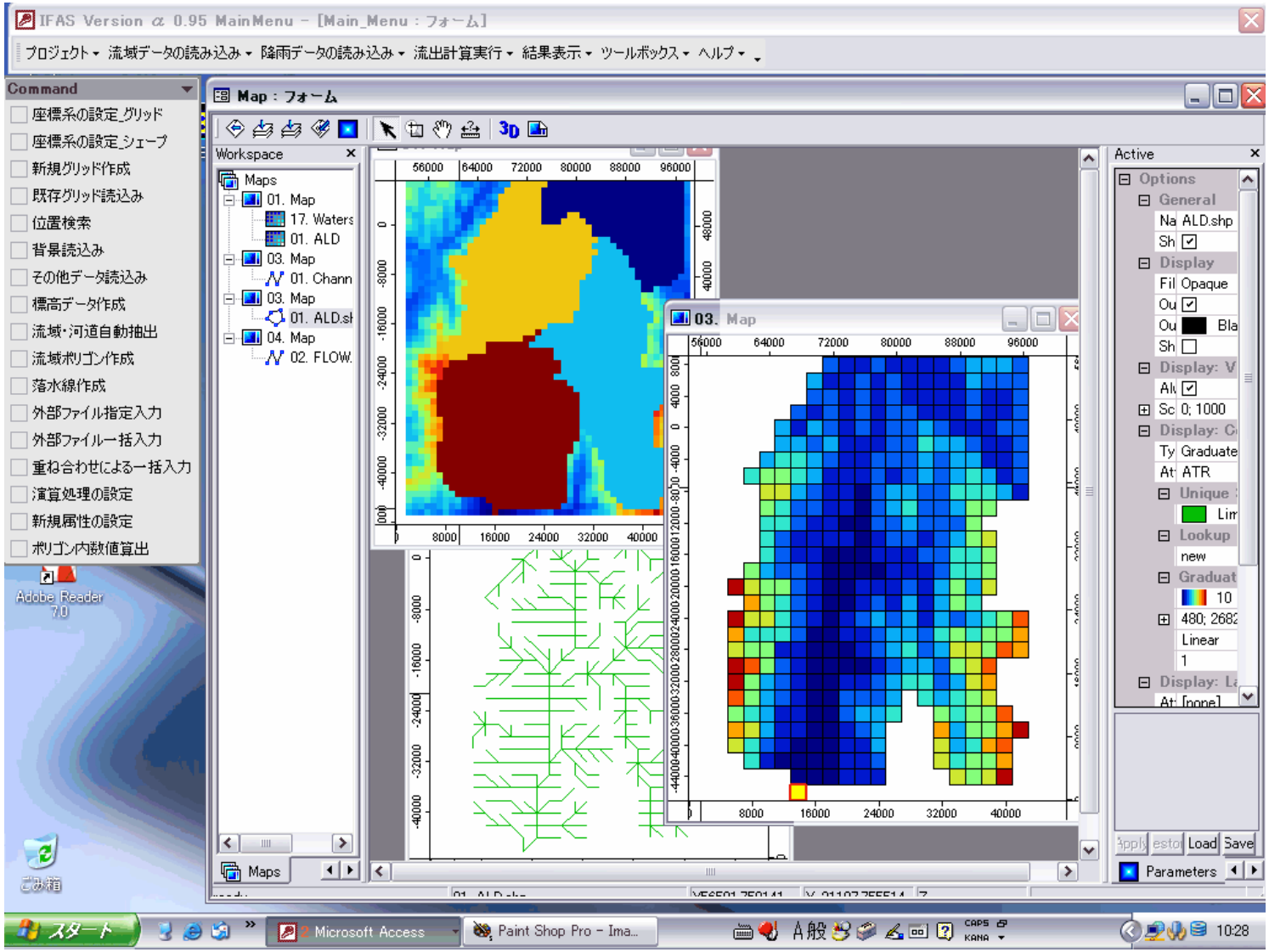
GIS analyses & hydrologic model building (Task 3)



As of alpha-version, August 2006

Possible applications of IFAS

- Utilization as a basic toolkit for quick and efficient implementations of flood forecasting and warning systems in developing countries
- Utilization as a toolkit for flood control planning and management in poory-gauged river watersheds
- Utilization as a common toolkit for training courses on flood runoff modeling and forecasting at ICHARM, etc.
- Combined use with GFAS

Future subjects (tentative, including for FY2007-)

- Evaluations of IFAS through real applications of IFAS in developing countries
- Refining interfaces and internal systems for realizing the flexible replacement of hydrologic simulation models based on object-oriented system
- Implementation of other typical hydrologic models and modules as default libraries in cooperation with their developers, such as
  BTOPMC model (Yamanashi Univ.),
  WEHY model (UCD-ICHARM/PWRI), etc.
- Implementation of extentions for flood forecasting and warning such as feedback system, evaluation of uncertainty, etc.

Thank you very much for your attention!

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

Fukui City on the left bank side of the Asuwa River (photographed on July 18)

Fukui City on the left bank side of the Asuwa River (photographed on July 18)

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UNESCO International Hydrological Programme

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