

Utilization of Satellite Precipitation Data for Flood Management



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- 5. Flood in the Yom River, September 2012*
- 6. Findings and Conclusion*

Background

Problems of hydrological observation and data collection for flood warning and forecasting

- ✗ Difficulty to get real-time hydrological data on the river basin
 - ✗ Insufficient installation and maintenance of ground observatory stations with real-time information network (rainfall, water level, flood discharge...).
 - ✗ Lack of data and model for flood warning and forecasting.
 - ✗ Limited budget and human resources for installation and maintenance of observatory station, flood warning and forecasting.
 - ✗ Insufficient framework to enhance technical skill and capacities.
- > Satellite monitoring can supplement and/or substitute ground observation for flood warning and forecasting, applicable to anytime, anywhere of the world.**



Rainfall observation by hand

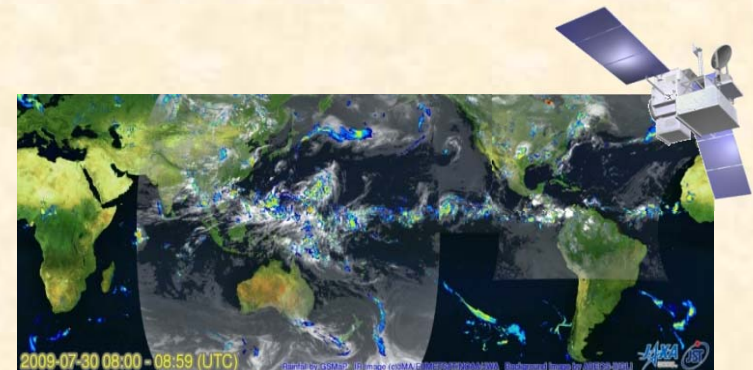
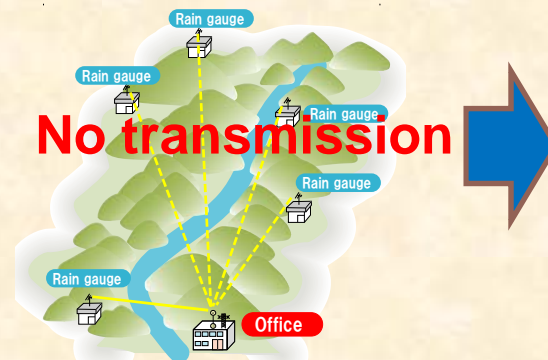


Image Source : JAXA

IFNet (International Flood Network)

Background

- ◆ *Rising trend of flood damages*
- ◆ *View of flood issues as locally limited problems*
- ◆ *Few networks that dedicated to flood issues*
- ◆ *Necessity to give priority to flood issues*

IFNet was set up as an open network everyone can join on the flood day of WWF3 in 2003.

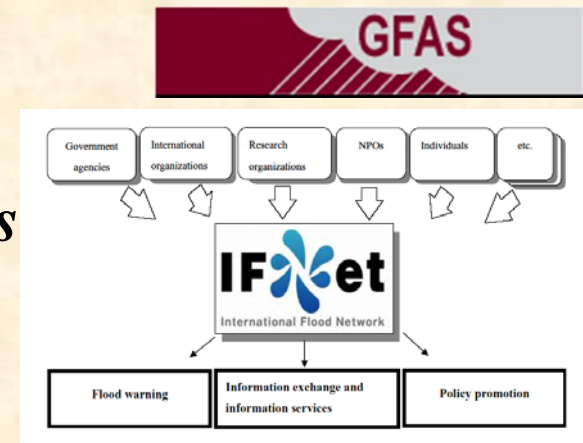
Objectives

To contribute to flood disaster reduction by:

- ◆ *Sharing knowledge and lessons,*
- ◆ *Promoting good practices,*
- ◆ *Raising awareness on flood risk among policy makers & citizen.*

Membership

- ◆ *IFNet is an **open, free network** to everyone, currently 634 registered from 83 countries (as of 31 December, 2012).*
- ◆ ***Advantage:** Opportunity to receive **GFAS** information*



Schematic figure of GFAS

i) Space agencies

```
*** Check latest data *** L.  
(2005/01/28 14:09:59)  
Connected to server!  
Obtain data list!  
Data list obtained:  
(1)3842RT.2005012821.bin.gz  
(2)3842RT.2005012700.bin.gz  
(3)3842RT.2005012708.bin.gz  
(4)3842RT.2005012708.bin.gz  
(5)3842RT.2005012709.bin.gz  
(6)3842RT.2005012712.bin.gz  
(7)3842RT.2005012715.bin.gz  
(8)3842RT.2005012718.bin.gz  
Latest data download completed!  
*** Latest data check completed *** L.  
(2005/01/28 14:10:37)
```

Satellite observation

GFAS

Heavy rainfall in the river basin

River

ii) IDI-Japan

Download of data

Data processing

Mapping, Email

System development

iv) Hydrological service
to river authorities

Flood warning and forecasting by
using GFAS Information etc.

iii) IFNet

1. IFNet Homepage
2. Email of heavy rain information to IFNet members in charge of flood forecasting and warning

v) Residents/
NGOs/
Community
leaders

Website of IFNet & GFAS



IFNeT Homepage: <http://www.internationalfloodnetwork.org/>



Precipitation data of the world by using satellite monitoring

GFAS

Global Flood Alert System - Web Version - Netscape Browser

http://210.255.213.236/gfas-web/

GLOBAL FLOOD ALERT SYSTEM (GFAS)
Trial running

As at 00:00, 03 04 2006 (GMT)

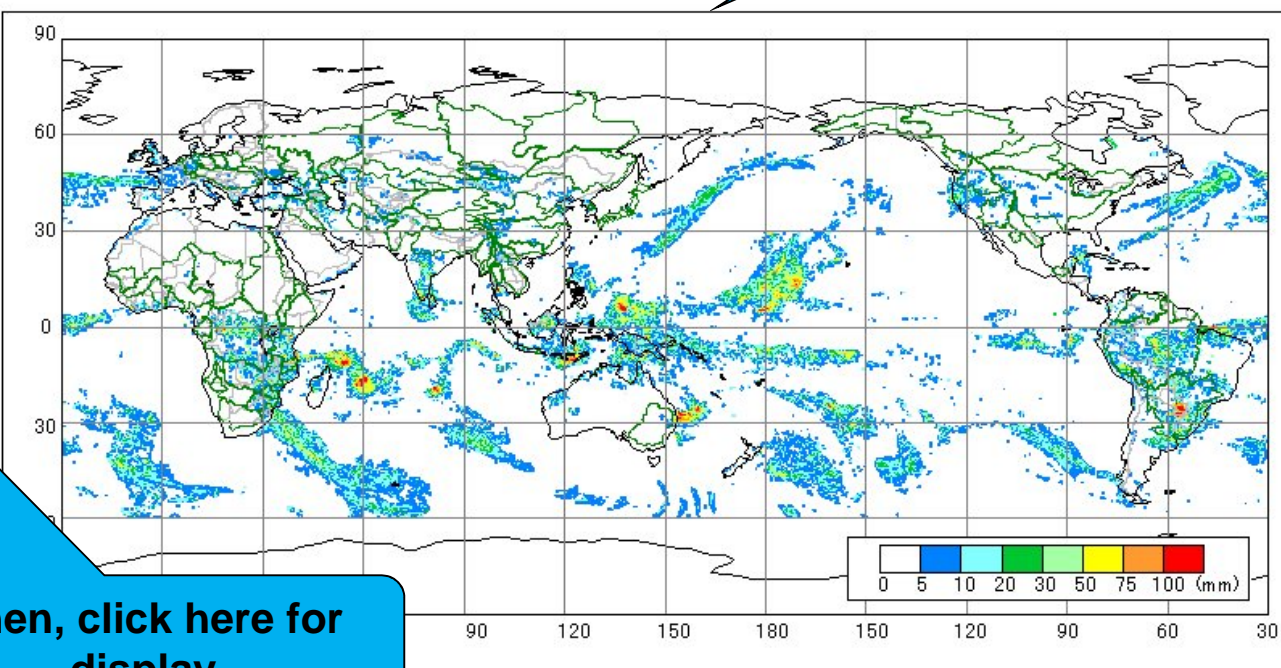
You can select 1 or 3-day rain fall from pull-down menu here.

You can select from 9 regions

Latest 1 day rainfall in the world is displayed on the initial page

Then, click here for display.

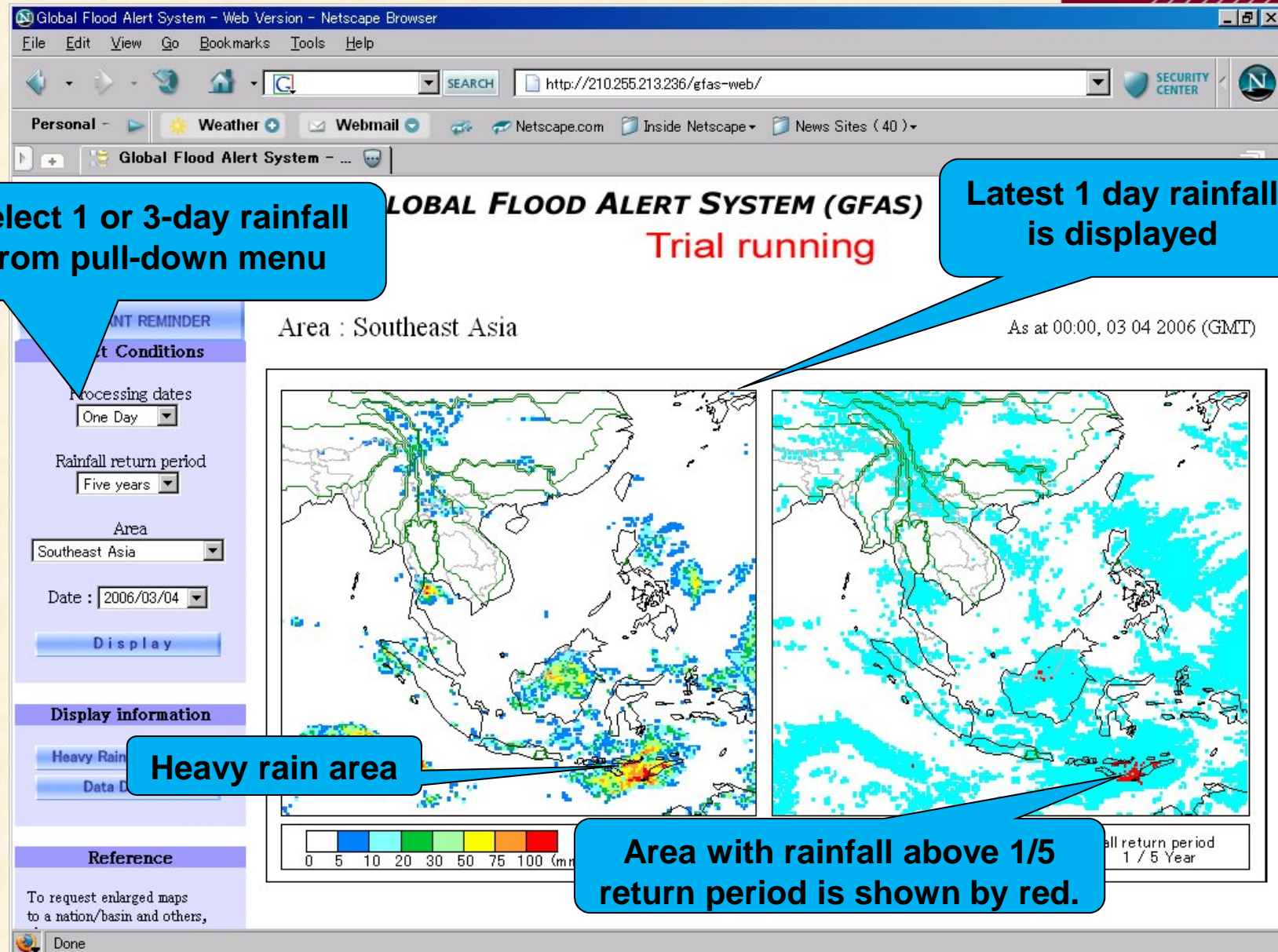
Processing date: One Day
Rainfall return period: Five years
Area: World
Date: 2006/03/04
Display
Display information
Heavy Rain Information
Data Download
Reference
To request enlarged map to a nation/basin and others,



0 5 10 20 30 50 75 100 (mm)

Done No Full Scan

GFAS : Daily precipitation data - Example of Southeast Asia

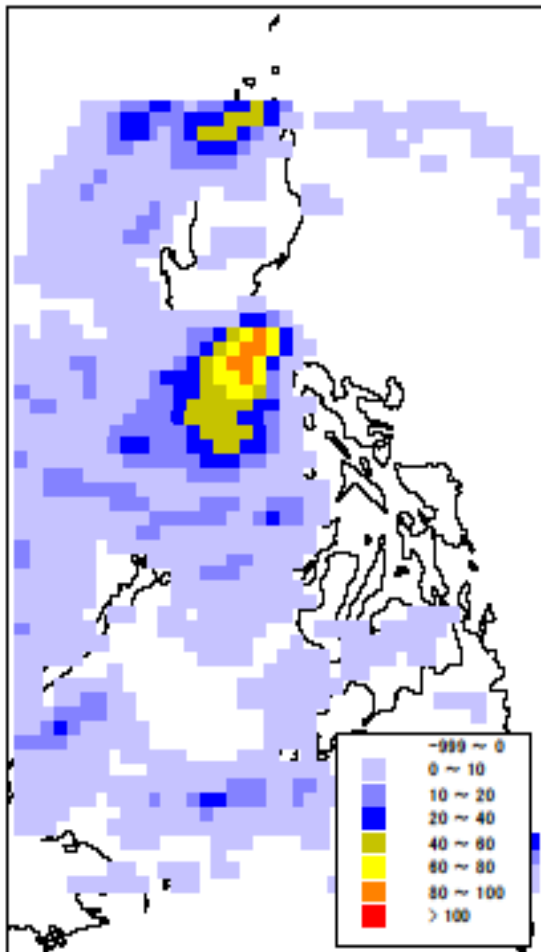


GFAS Up-grading 3B42RT >>> GSMaP

Typhoon Ketsana on the Philippines (2009/09/26 daily)

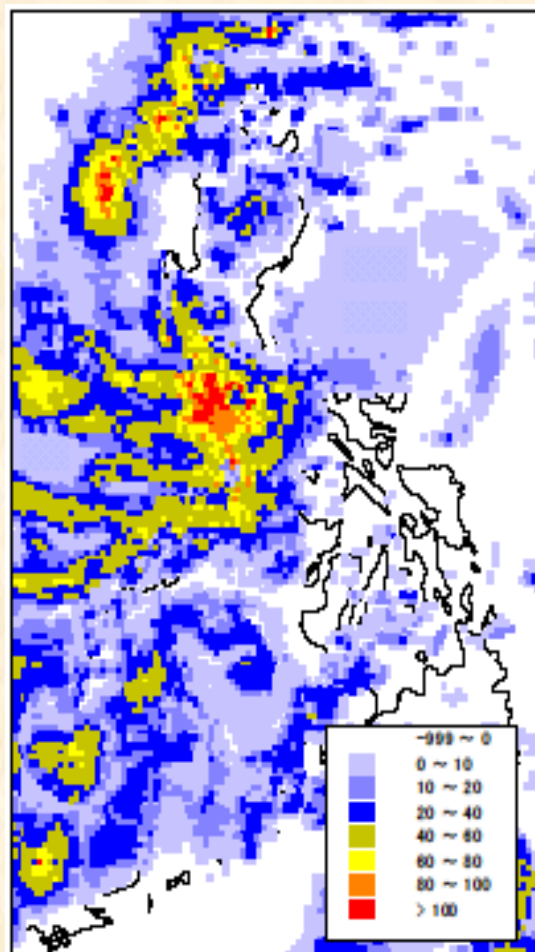
3B42RT (1998-2008)

- Mesh size: 0.25°
- data delay: 10 hours



GSMaP (2007-)

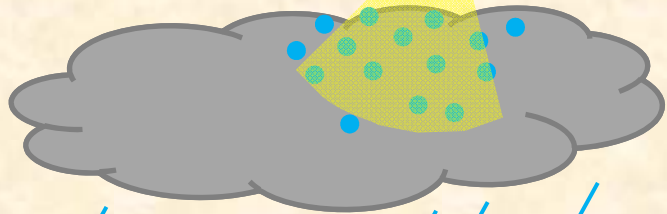
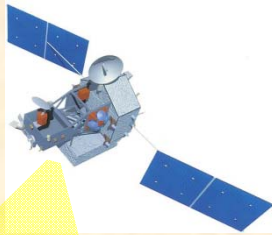
- Mesh size: 0.1° ($10 \times 10 \text{ km}^2$)
- data delay: 4 hours



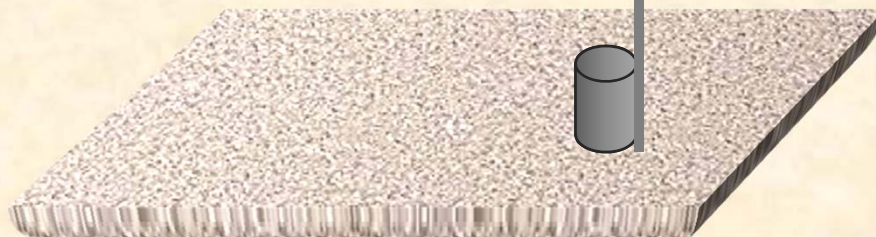
Up-grading from 3B42RT to GSMaP enabled more detailed and more rapid transmission of precipitation data.

2. GFAS Development (1): Correlation between satellite monitoring and ground observation

Satellite Monitoring



Ground observation

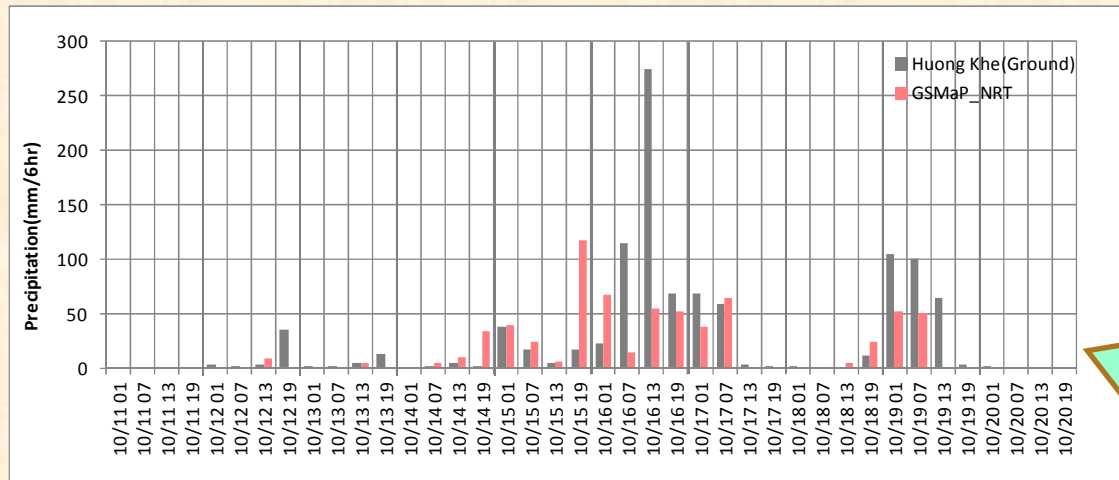


*In order to estimate ground precipitation, **correlation between satellite monitoring data and ground precipitation data has been studied.***

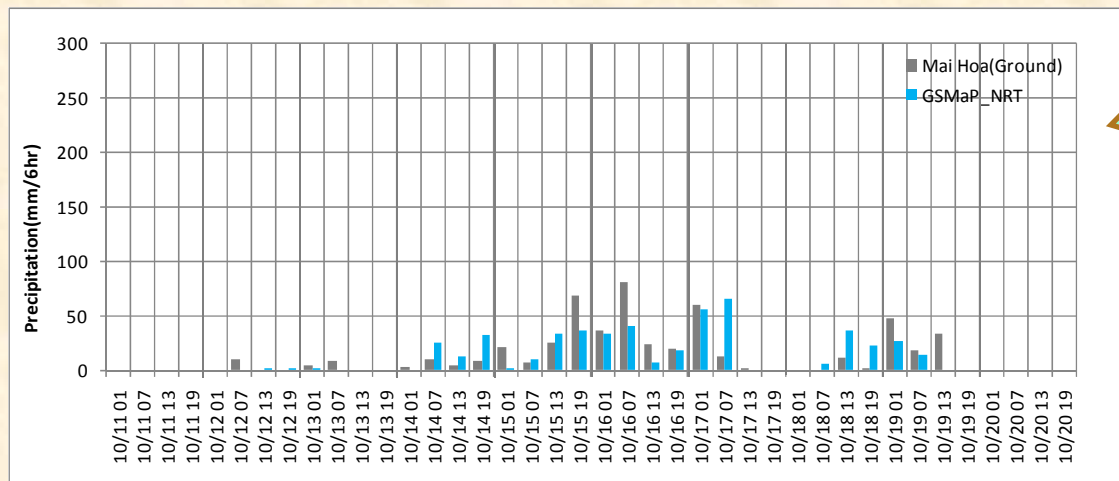


*Pilot study areas:
Huong Khe (Ha Tinh),
Mai Hoa (Quang Binh)*

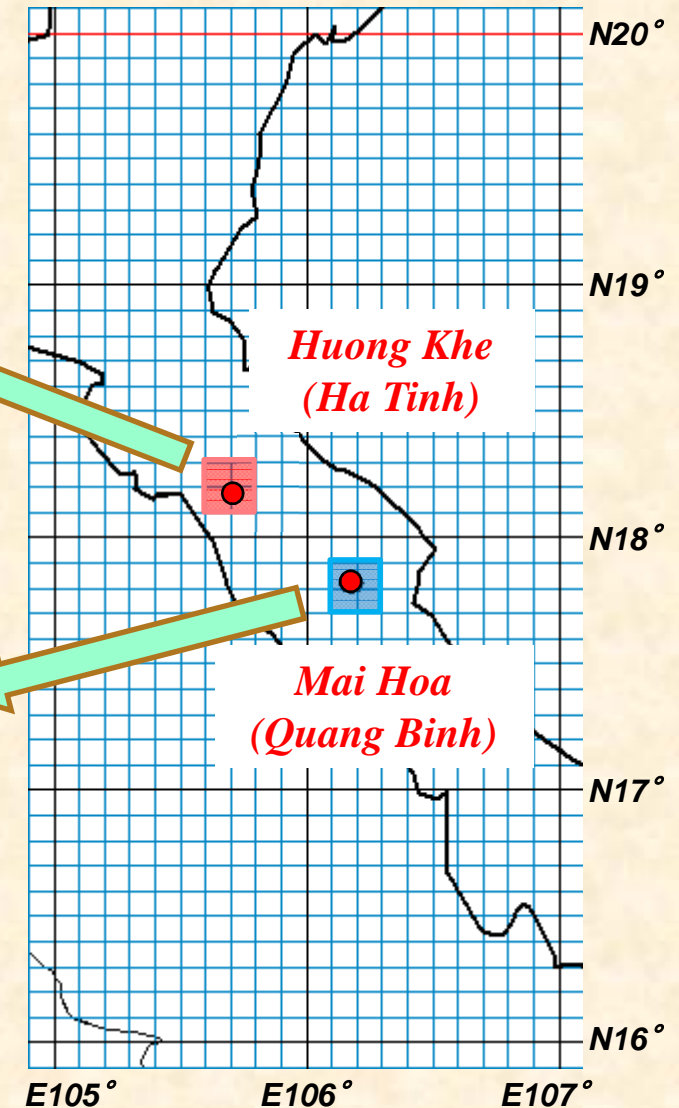
6-hours precipitation 2010/10/11-10/20



Huong Khe, Ha Tinh (R=0.158)

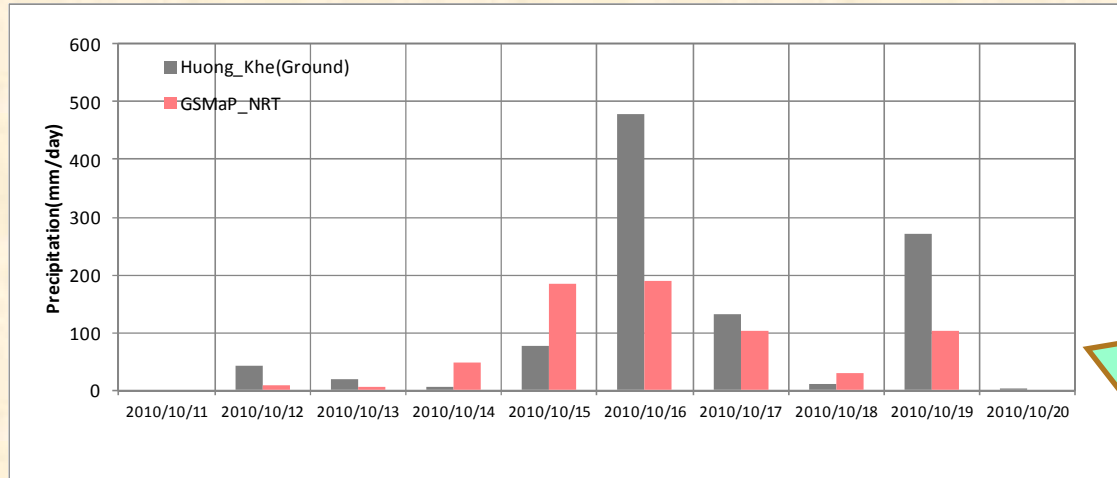


Mai Hoa, Quang Binh (R=0.499)

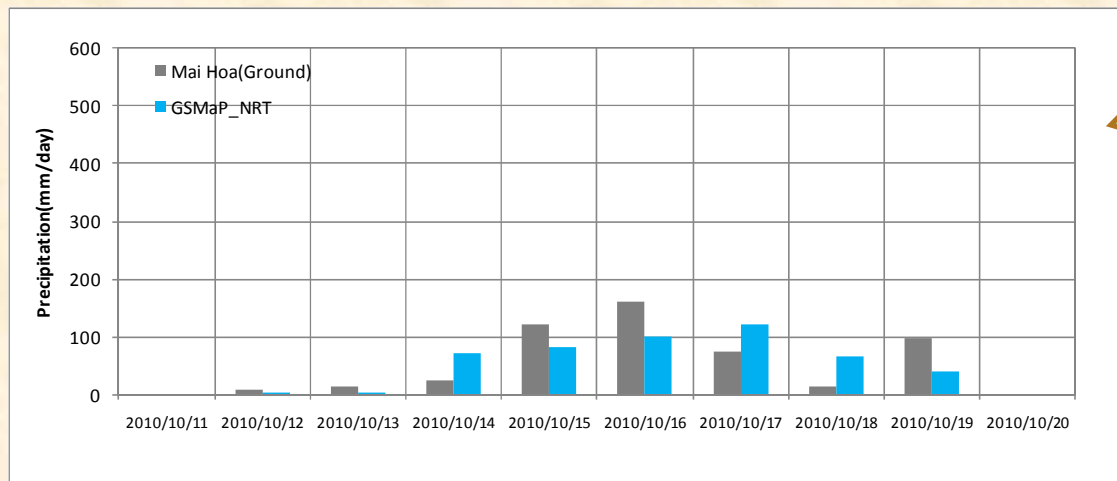


Note: GSMaP_NRT data is the maximum one among the four mesh data. (□ □)

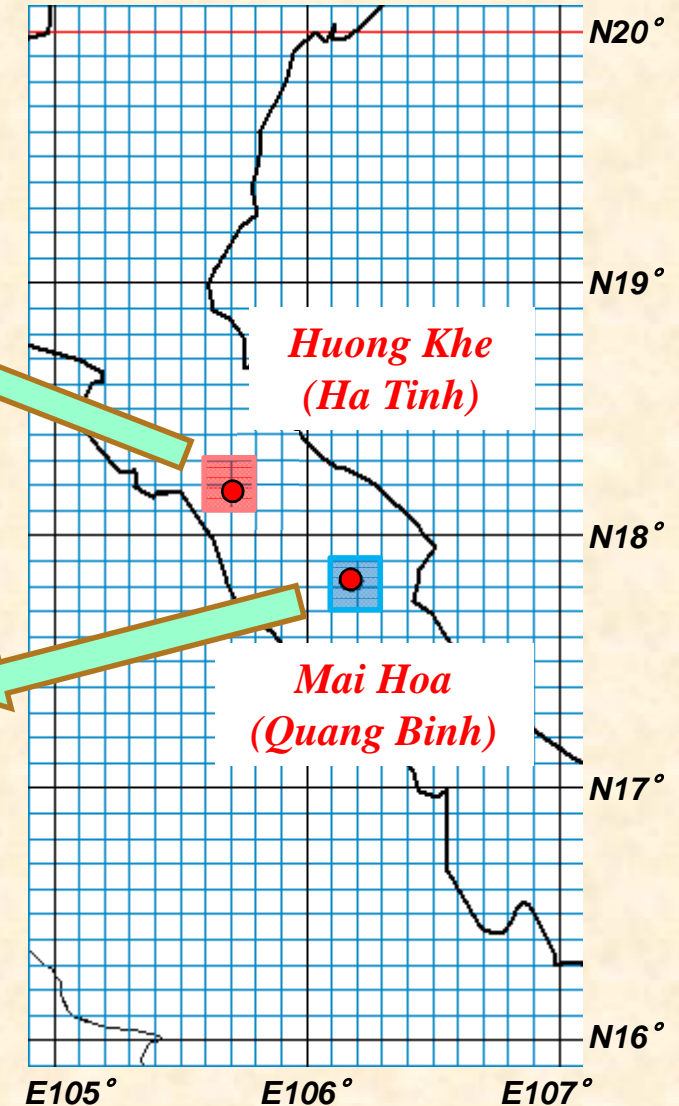
1-day precipitation 2010/10/11-10/20



Huong Khe, Ha Tinh (R=0.598)

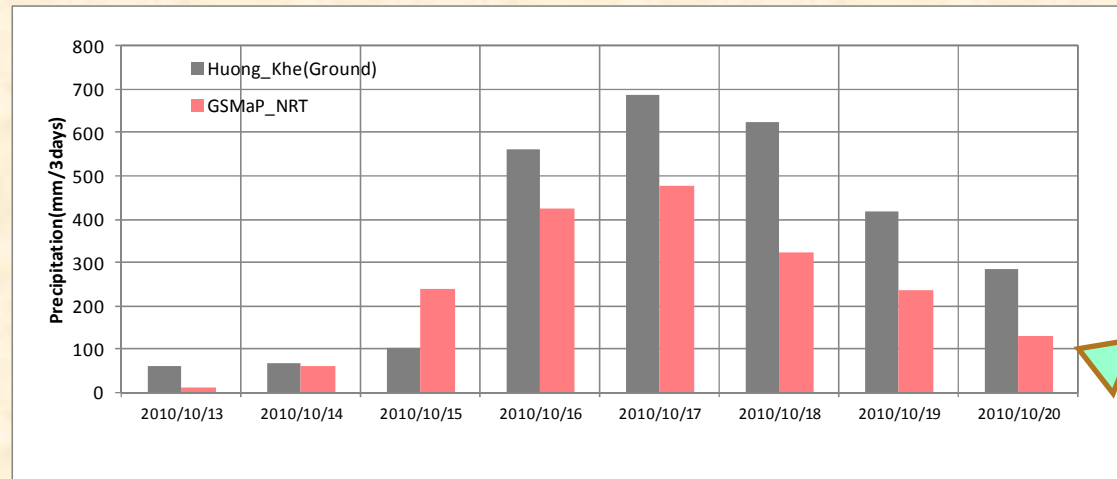


Mai Hoa, Quang Binh (R=0.306)

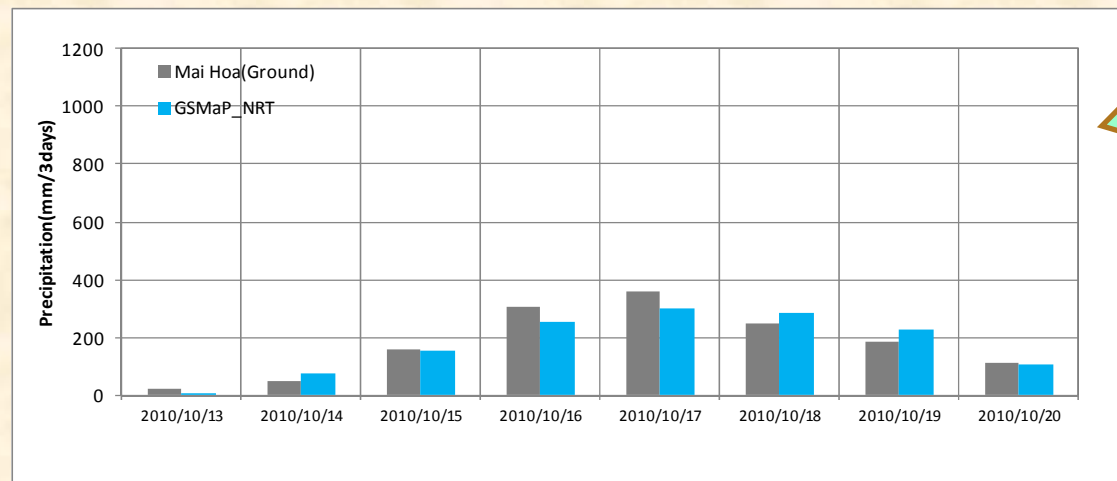


Note: GSMaP_NRT data is the maximum one among the four mesh data. (□ □)

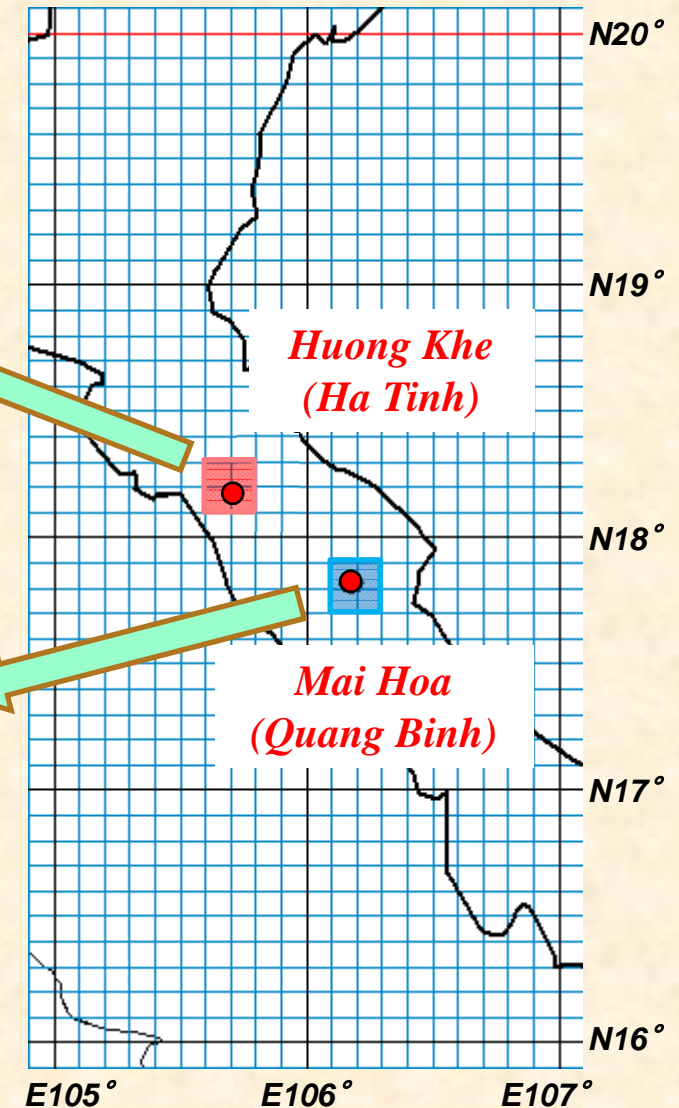
3-days precipitation 2010/10/11-10/20



Huong Khe, Ha Tinh (R=0.881)



Mai Hoa, Quang Binh (R=0.942)



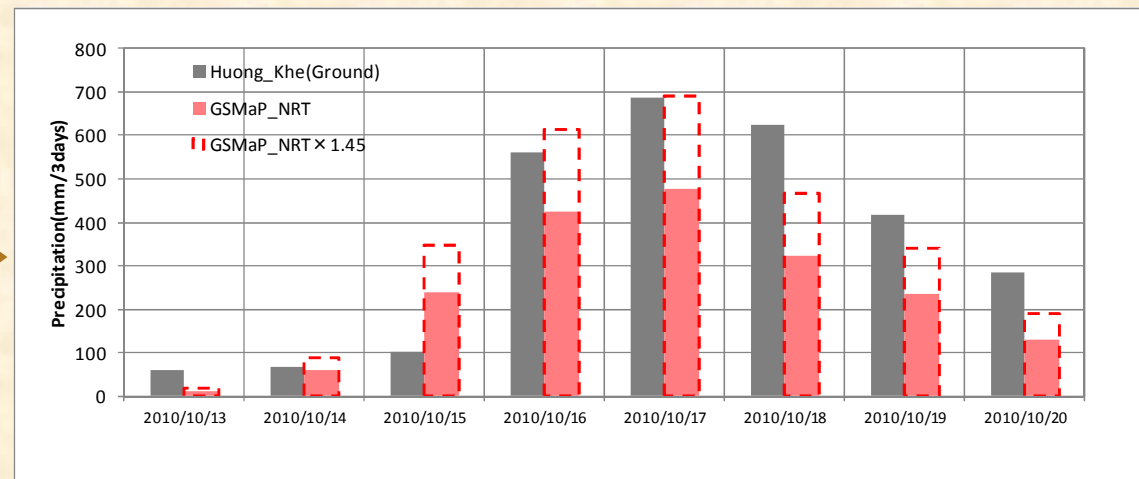
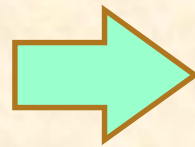
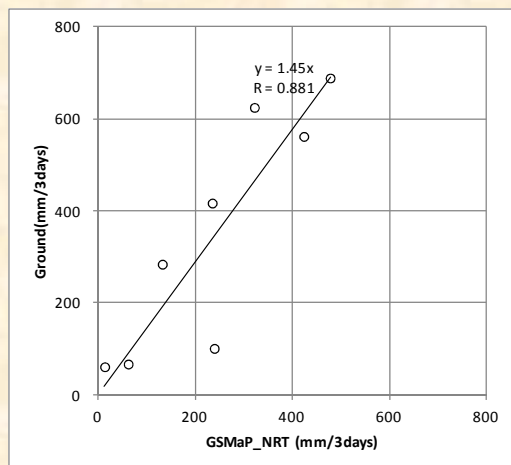
Note: GSMaP_NRT data is the maximum one among the four mesh data. (□ □)

Estimation of ground precipitation by using satellite monitoring data

correlation coefficient between ground data and satellite data

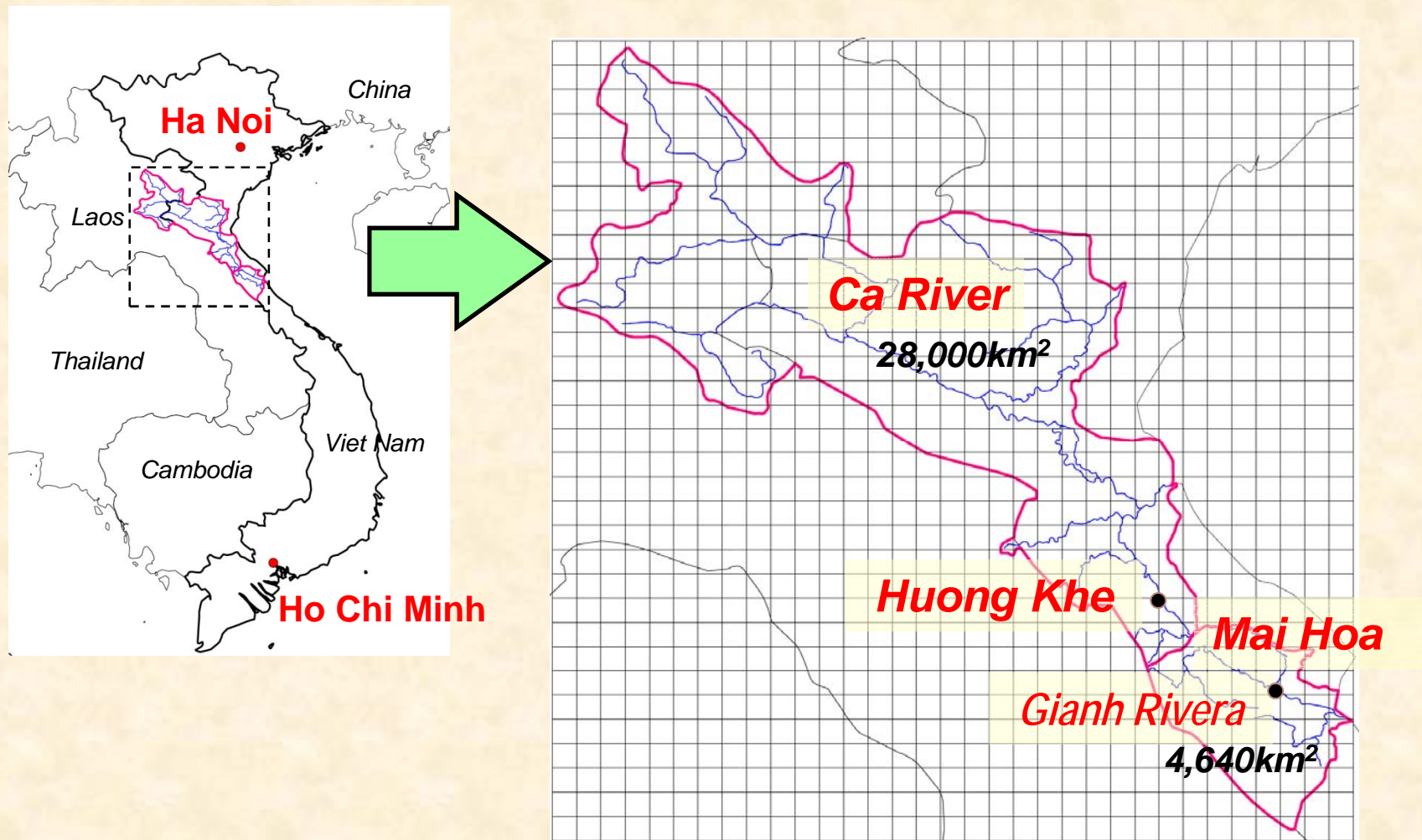
	Huong Khe	Mai Hoa
6-hours precipitation	0.158	0.499
1-day precipitation	0.598	0.306
3-days precipitation	0.881	0.942

Ground precipitation can be estimated by using the satellite monitoring data, considering the high correlation coefficient of 3-days precipitation data.

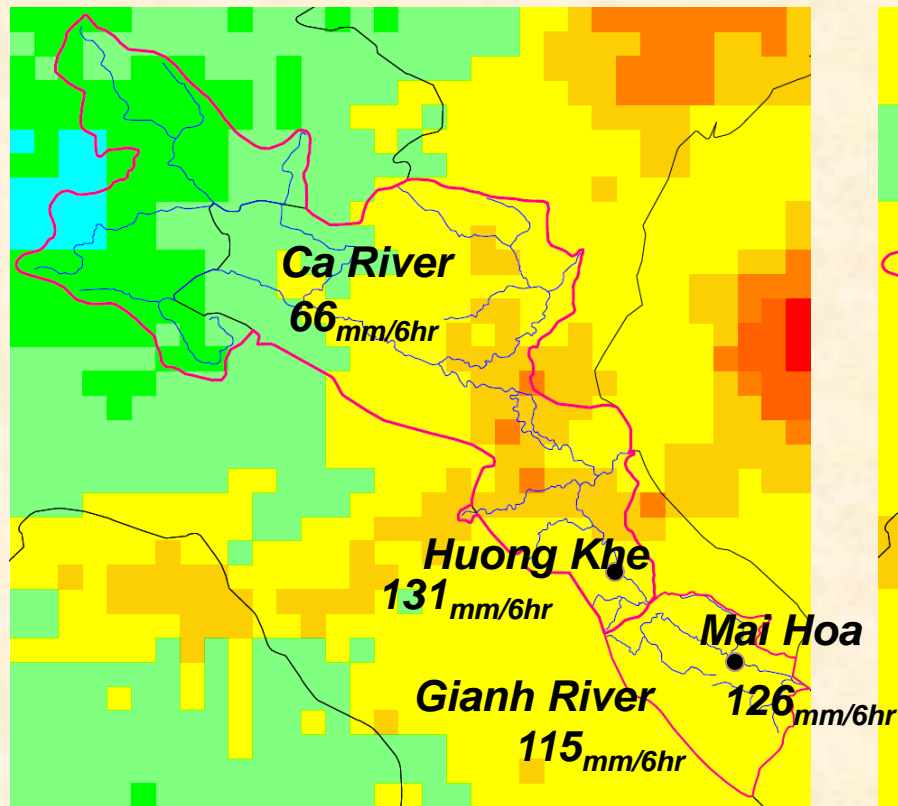
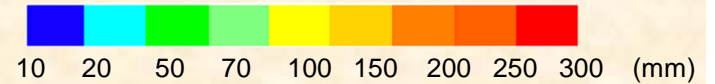


2. GFAS Development (2): Estimation of probable precipitation with return period (1/3, 1/5, 1/10...)

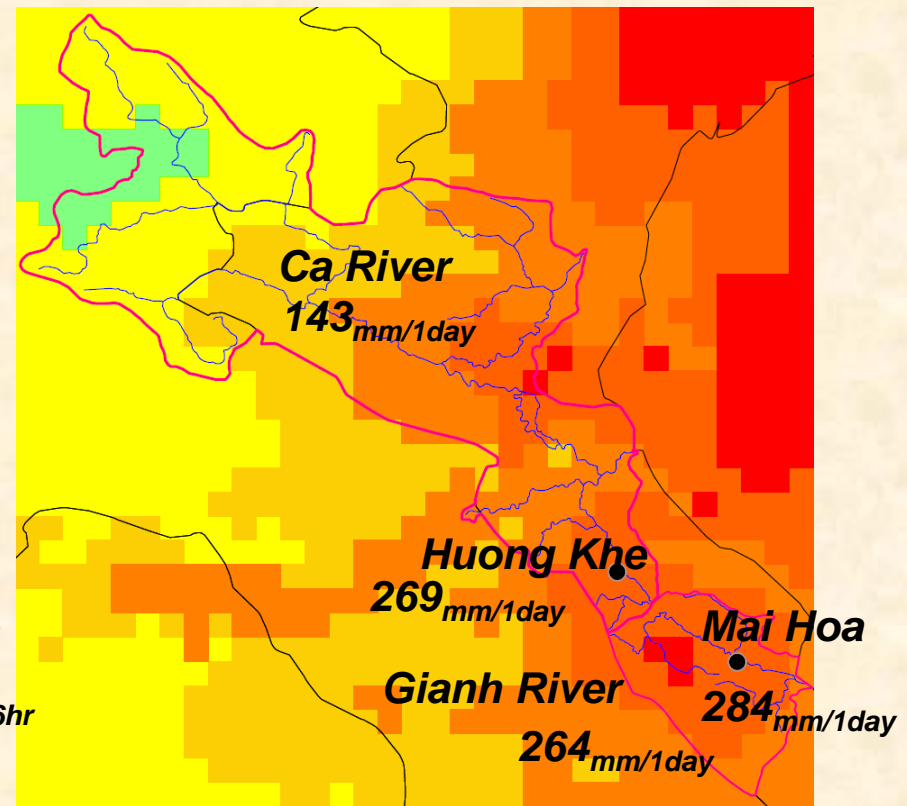
***Pilot Areas :Huong Khe, Ca River Basin
Mai Hoa, Gianh River Basin***



6-hours and 1-day precipitation of 10-years return period (1/10)



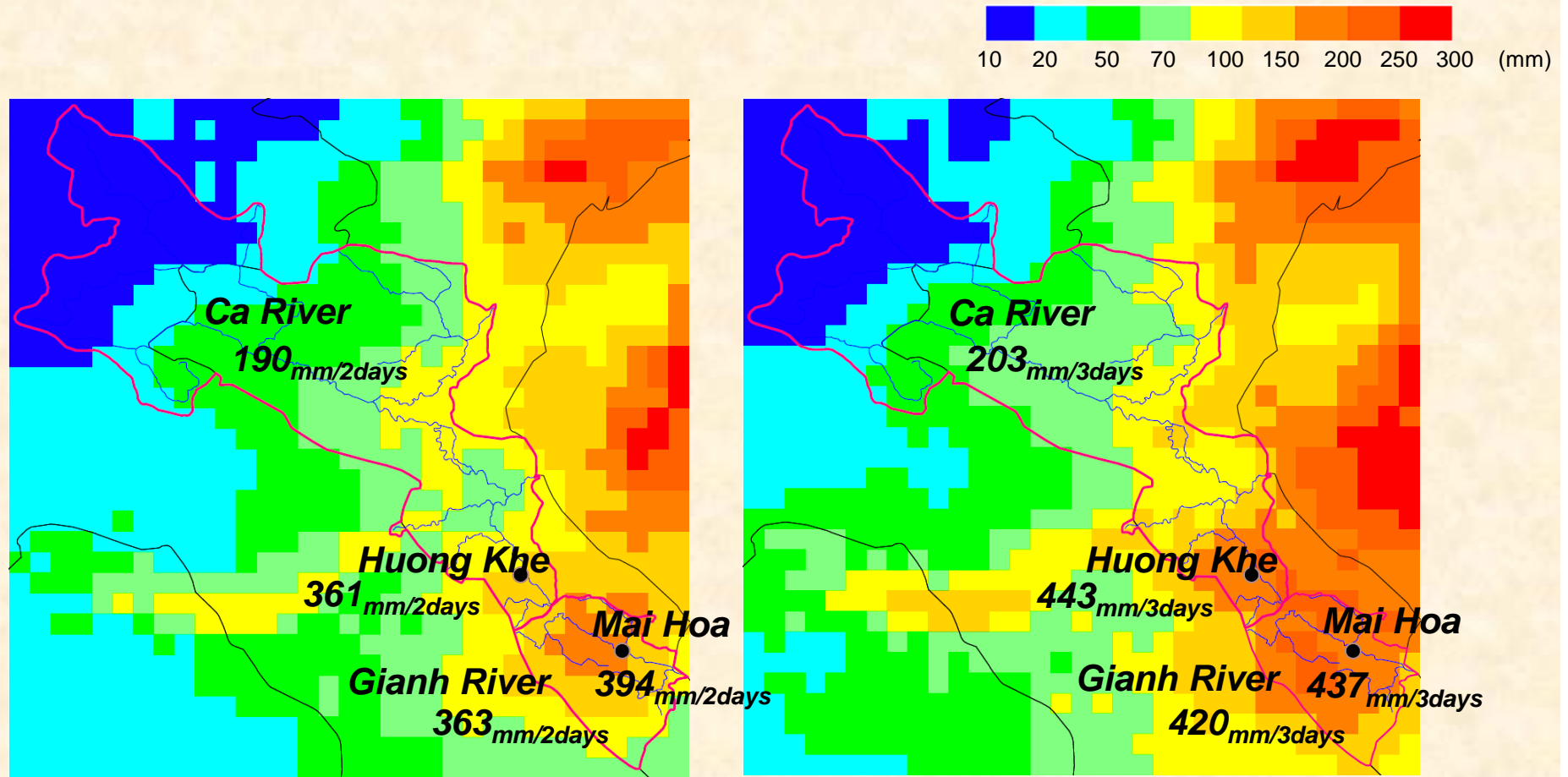
6-hours precipitation



1-day precipitation

Used Data:2003-2011 (9 years)

2-days and 3-days precipitation of 10-years return period (1/10)



2-days precipitation

3-days precipitation

Used Data: 2003-2011 (9 years)

Utilization of probable precipitation with return period for flood management

Probable 3-days precipitation
of 1/3, 1/5, 1/30... of each river

	Ca River	Gianh River
1/3	156 mm	252 mm
1/5	177 mm	317 mm
1/10	203 mm	420 mm
1/30	243 mm	633 mm
...

Probable precipitation (1/5, 1/10...) can
be calculated from GSMap data (2003-11)

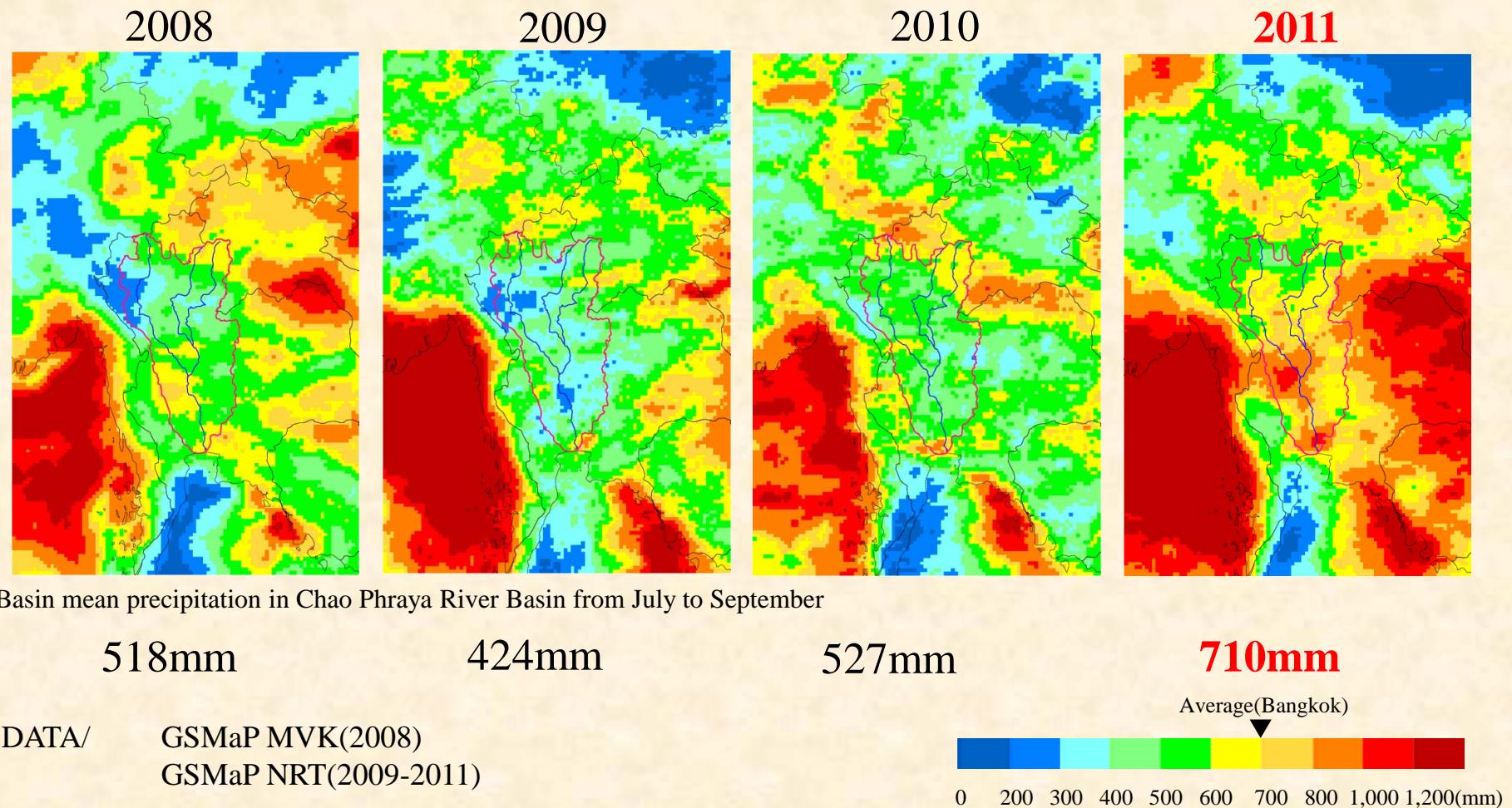
Alert level can be examined,
much better be testified by
using the ground observatory
data, if available

Flood Alert

- Start of people's evacuation
- Preparation for flood defense activities

3. Flood in the Chao Phraya River, 2011

By using satellite-monitoring data from GSMaP, 3 month's basin-average precipitation (July-September of 2008-2011) were analyzed without using any ground observatory data.



Monthly precipitation of the Chao Phraya River basin

	2008	2009	2010	Average of 3 years (2008-2010)	2011 (compared to 3 years average)
July	164mm	128mm	147mm	146mm	205mm (140%)
August	164mm	151mm	217mm	177mm	225mm (127%)
September	190mm	145mm	162mm	166mm	279mm (168%)
Total rainfall in 3 months	518mm	424mm	527mm	490mm	710mm (145%)

*More rain in July-August of 2011 than those of the previous three years, and **much more rain in September.***

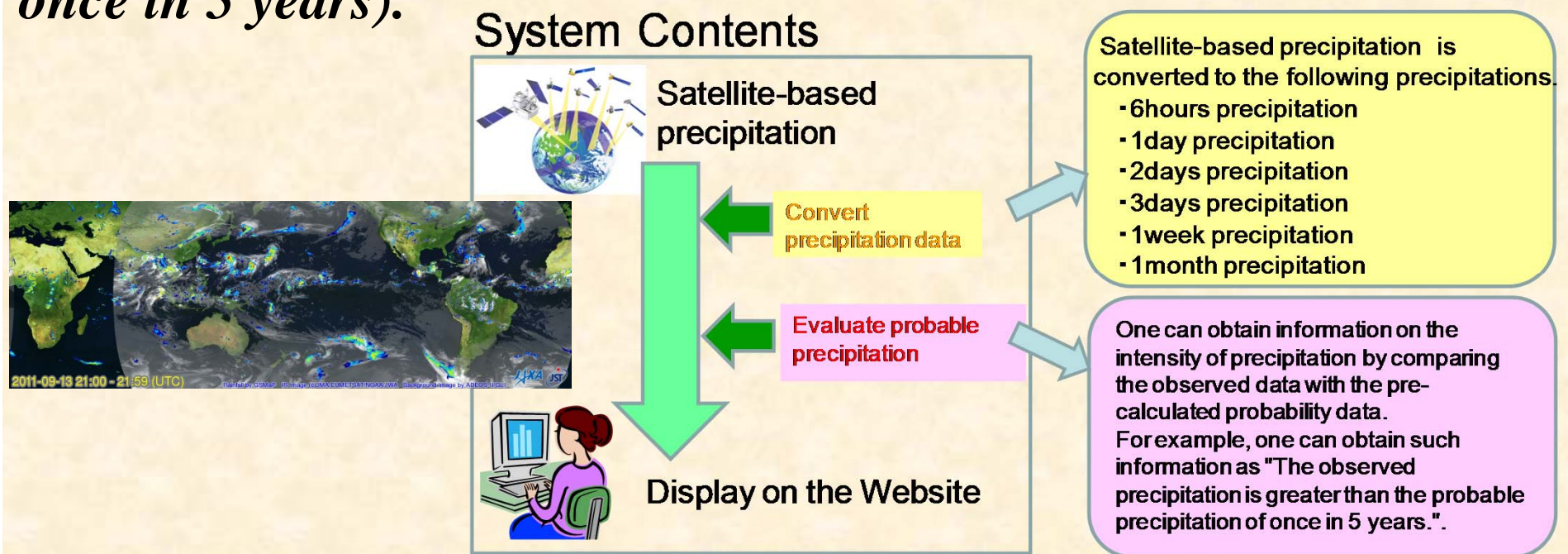
*At the end of August, we already knew **the precipitation of this year is bigger than the previous ones...***

*If we knew about this trend in advance, could we **foresee today's serious situation?** or **at least well prepared?***

4. Development of Satellite-Based Precipitation Data Delivery System for Thailand

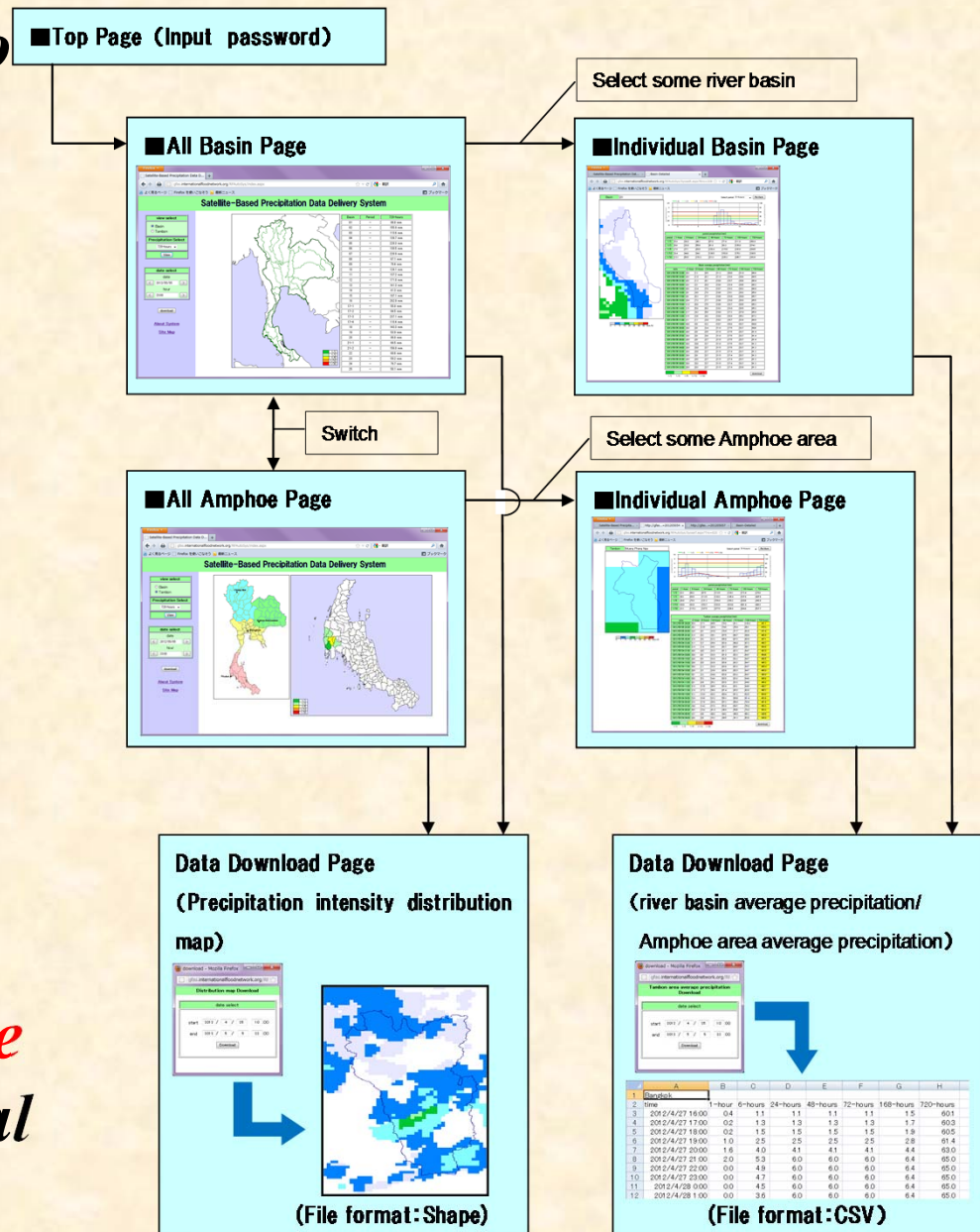
By using the GSMaP data, average precipitation for specific river basin and region (Amphoe) can be calculated.

Also, notification signal can be displayed when the observed basin or regional average precipitation exceeds the pre-calculated probable precipitation with some return periods (for example, once in 5 years).



System configuration

- *A password will be required to enter the top page.*
- *Select the individual basin from all basin page.*
- *You can switch from all basin page to all Amphoe page.*
- *Select the individual Amphoe from all Amphoe page.*
- *You can download the distribution map at all basin and Amphoe page.*
- *You can download the average precipitation data at individual basin and Amphoe page.*



System operation – Basin page <1/2>

■ All basin page

Select Basin or Amphoe.

Select precipitation.

- 1 hour
- 6 hours
- 1 day
- 2 days
- 3 days
- week
- month

Select date and time(hour) to display.

Distribution map of cumulative precipitation is shown.

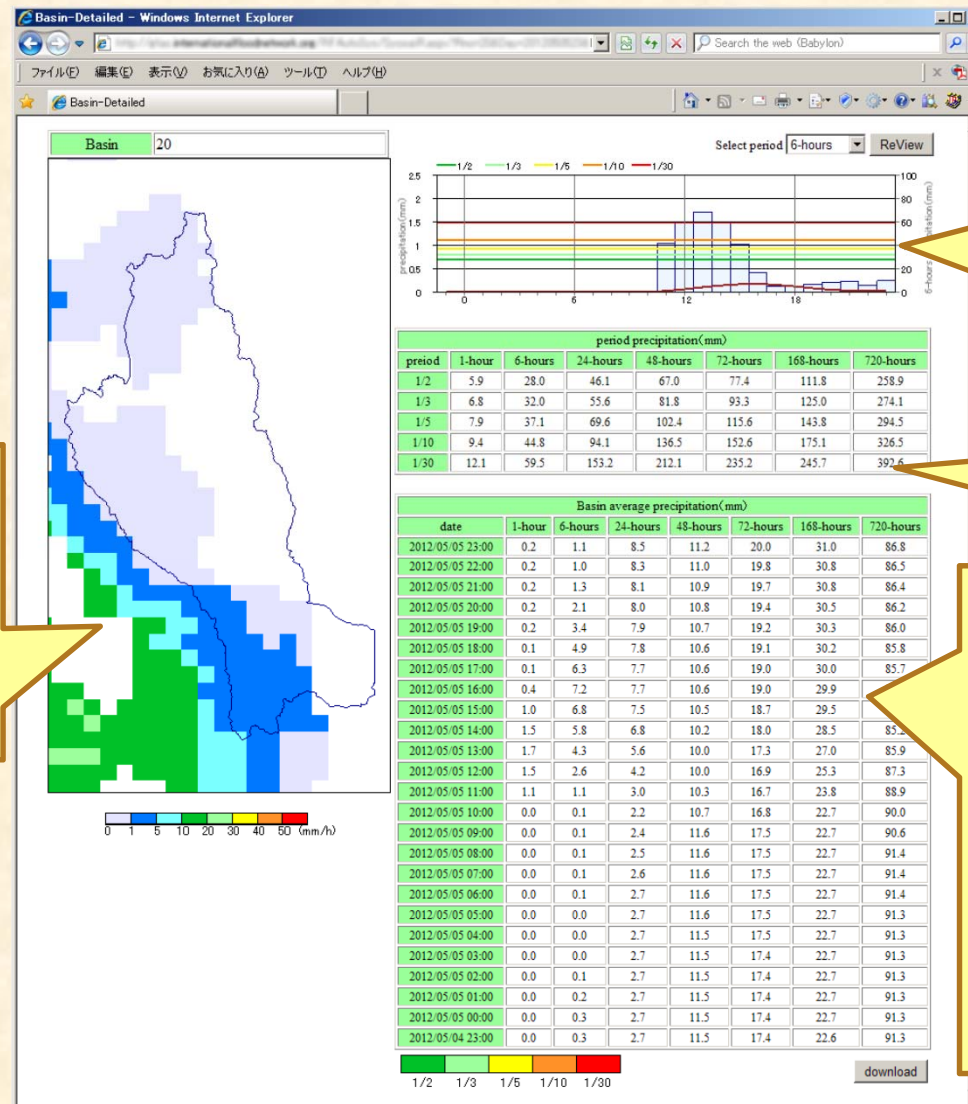
Precipitation data is shown for the selected date/time and cumulative precipitation.

Click on a basin!

Basin	Period	720-hours
01	—	81.8 mm
02	—	127.3 mm
03	—	123.2 mm
04	—	142.3 mm
05	—	260.9 mm
06	—	123.4 mm
07	—	288.5 mm
08	—	86.0 mm
09	—	67.2 mm
10	—	104.4 mm
11	—	132.5 mm
12	—	210.8 mm
13	—	136.3 mm
14	—	33.1 mm
15	—	201.0 mm
16	—	286.8 mm
17-1	—	66.7 mm
17-2	—	92.3 mm
17-3	—	300.0 mm
17-4	—	156.5 mm
18	—	156.2 mm
19	—	38.7 mm
20	—	91.3 mm
21-1	—	52.0 mm
21-2	—	156.0 mm
22	—	57.0 mm
23	—	47.3 mm
24	—	67.3 mm
25	—	32.3 mm

System operation – Basin page <2/2>

Individual Basin Page



The screen displays the satellite-based hourly precipitation of the selected date.

Cumulative precipitation and hourly precipitation are shown on a graph.

Probable precipitation is shown in a table.

Cumulative precipitation is shown 24hr before the selected time/date. When the observed precipitation exceeds the probable precipitation, the cell becomes to be colored.

System operation – Amphoe page <1/2>

■ All Amphoe Page

The screenshot shows a web browser window titled "Satellite-Based Precipitation Data Delivery System - Windows Internet Explorer". The address bar shows the URL "http://fms.internationalfloridatrust.org/707/AutoSys/index.aspx". The browser's menu bar includes "ファイル(F)", "編集(E)", "表示(V)", "お気に入り(A)", "ツール(T)", and "ヘルプ(H)". The browser's toolbar includes buttons for "Satellite-Based Precipitation Data Delivery System", "Search the web (Babylon)", and various navigation icons.

The main content area has a green header with the title "Satellite-Based Precipitation Data Delivery System". Below the header, there are three main sections:

- view select**: Contains radio buttons for "Basin" and "Amphoe". The "Amphoe" option is selected.
- Precipitation Select**: Contains a dropdown menu set to "720-hours" and a "View" button.
- date select**: Contains a "date" section with a calendar icon and a text input field showing "2012/05/05", and a "hour" section with a text input field showing "4:00". There are also "download" and "About System" links.

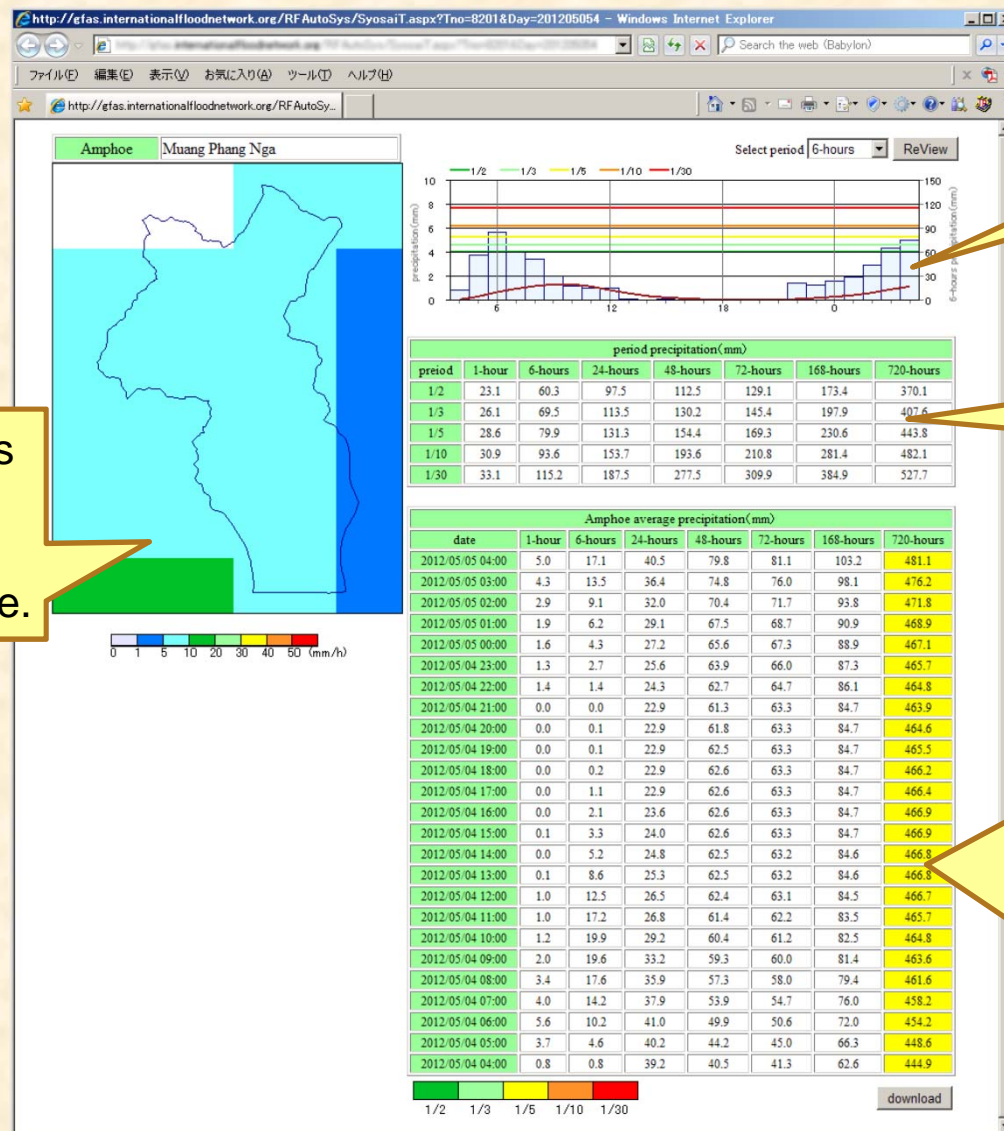
On the right side, there are two maps of Thailand. The left map shows the country divided into regions, with labels for "Chiang Mai", "Nakhon Ratchasima", "Bangkok", and "Phuket". A red arrow points to the "Phuket" region. The right map shows the country divided into provinces, with a red arrow pointing to a specific province in the western part of the country. A red box with the text "Click on a Amphoe!" is overlaid on the right map. A legend in the bottom right corner shows a color scale from green to red, with values: 1/2, 1/3, 1/5, 1/10, and 1/30.

Four yellow callout boxes provide instructions:

- Select Basin or Amphoe.**: Points to the "view select" section.
- Select precipitation**:
 - 1 hour
 - 6 hours
 - 1 day
 - 2 days
 - 3 days
 - week
 - monthPoints to the "Precipitation Select" section.
- Select date and time(hour) to display.**: Points to the "date select" section.
- Click on an area to which Amphoe belongs!**: Points to the left map.

System operation – Amphoe page <2/2>

Individual Amphoe Page



The screen displays the satellite-based hourly precipitation of the selected date.

Cumulative precipitation and hourly precipitation are shown on a graph.

Probable precipitation is shown in a table.

Cumulative precipitation is shown 24hr before the selected time/date. When the observed precipitation exceeds the probable precipitation, the cell becomes to be colored.

System operation – Data Download page <1/2>

■ Data Download Page (Precipitation intensity distribution map)

The screenshot displays the 'Satellite-Based Precipitation Data Delivery System' web application. The main interface is divided into several sections:

- view select:** Includes radio buttons for 'Basin' (selected) and 'Amphoe'.
- Precipitation Select:** A dropdown menu set to '720-hours' and a 'View' button.
- date select:** Includes a 'date' field set to '2012/05/05' and a 'hour' field set to '4:00', with navigation arrows.
- download:** A button at the bottom of the left sidebar.
- About System / System configuration:** Links at the bottom of the left sidebar.

A red arrow points from the 'download' button to a secondary window titled 'download - Windows Internet Explorer'. This window shows the 'Distribution map Download' page with a 'date select' section:

- start:** 2012 / 4 / 25 0 :00
- end:** 2012 / 5 / 14 23 :00
- Download:** A button to initiate the download.

A red arrow points from the 'Download' button in the secondary window to a map of Japan. The map is overlaid with a grid of colored squares representing precipitation intensity. A red box highlights a portion of the map, and a red arrow points from this box to a third window showing a detailed view of the precipitation data. This window displays a map of a specific region with a grid of colored squares, and a table on the right side with columns 'Basin' and 'Pen'.

Red text boxes with arrows provide instructions:

- Click !** (points to the 'download' button in the main interface)
- Select start and end date, and click on the "Download" button!** (points to the 'date select' section in the secondary window)
- Satellite-based precipitation data (shp file) is downloaded.** (points to the detailed map view)

System operation – Data download page <2/2>

■ Data Download Page

(Precipitation data for specific river basin and Amphoe)

Amphoe area average precipitation Download

date select

start 2012 / 4 / 25 0 :00

end 2012 / 5 / 14 23 :00

Download

Click !

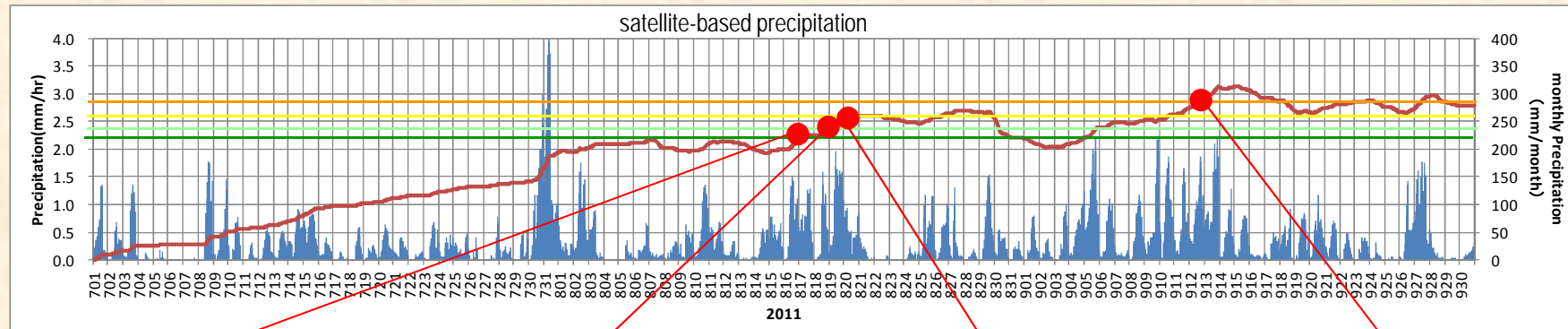
Select start and end date, and click on the "Download" button!

Satellite-based precipitation data (csv file) is downloaded.

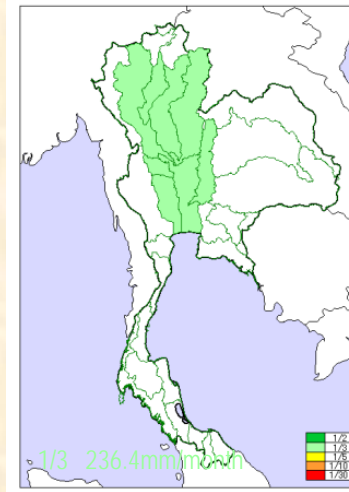
	A	B	C	D	E	F	G	H
1	Bangkok							
2	time	1-hour	6-hours	24-hours	48-hours	72-hours	168-hours	720-hours
3	2012/4/27 16:00	0.4	1.1	1.1	1.1	1.1	1.5	60.1
4	2012/4/27 17:00	0.2	1.3	1.3	1.3	1.3	1.7	60.3
5	2012/4/27 18:00	0.2	1.5	1.5	1.5	1.5	1.9	60.5
6	2012/4/27 19:00	1.0	2.5	2.5	2.5	2.5	2.8	61.4
7	2012/4/27 20:00	1.6	4.0	4.1	4.1	4.1	4.4	63.0
8	2012/4/27 21:00	2.0	5.3	6.0	6.0	6.0	6.4	65.0
9	2012/4/27 22:00	0.0	4.9	6.0	6.0	6.0	6.4	65.0
10	2012/4/27 23:00	0.0	4.7	6.0	6.0	6.0	6.4	65.0
11	2012/4/28 00:00	0.0	4.5	6.0	6.0	6.0	6.4	65.0
12	2012/4/28 1:00	0.0	3.6	6.0	6.0	6.0	6.4	65.0
13	2012/4/28 2:00	0.0	2.0	6.0	6.0	6.0	6.4	65.0
14	2012/4/28 3:00	0.0	0.0	6.1	6.1	6.1	6.4	65.0
15	2012/4/28 4:00	0.0	0.1	6.1	6.1	6.1	6.5	65.1
16	2012/4/28 5:00	0.0	0.1	6.1	6.1	6.1	6.5	65.1
17	2012/4/28 6:00	0.0	0.1	6.1	6.1	6.1	6.5	65.1
18	2012/4/28 7:00	0.0	0.1	6.1	6.1	6.1	6.4	65.1
19	2012/4/28 8:00	0.0	0.1	6.1	6.1	6.1	6.4	65.1
20	2012/4/28 9:00	0.0	0.1	6.1	6.1	6.1	6.4	65.1
21	2012/4/28 10:00	0.0	0.0	6.1	6.1	6.1	6.4	65.1
22	2012/4/28 11:00	0.0	0.0	6.1	6.1	6.1	6.4	65.1
23	2012/4/28 12:00	0.0	0.0	6.1	6.1	6.1	6.4	65.1
24	2012/4/28 13:00	0.0	0.0	6.1	6.1	6.1	6.4	65.1
25	2012/4/28 14:00	0.0	0.0	6.0	6.1	6.1	6.4	65.1
26	2012/4/28 15:00	0.0	0.0	5.4	6.1	6.1	6.4	65.1
27	2012/4/28 16:00	0.0	0.0	5.0	6.1	6.1	6.4	65.1
28	2012/4/28 17:00	0.0	0.0	4.8	6.1	6.1	6.4	65.1
29	2012/4/28 18:00	0.0	0.0	4.6	6.1	6.1	6.4	65.1
30	2012/4/28 19:00	0.0	0.0	3.7	6.1	6.1	6.4	65.1
31	2012/4/28 20:00	0.0	0.0	2.0	6.1	6.1	6.4	65.1
32	2012/4/28 21:00	0.0	0.0	0.1	6.1	6.1	6.4	65.1
33	2012/4/28 22:00	0.0	0.0	0.1	6.1	6.1	6.4	65.1
34	2012/4/28 23:00	0.0	0.0	0.1	6.1	6.1	6.4	65.1
35	2012/4/29 0:00	0.0	0.0	0.1	6.1	6.1	6.4	65.1
36	2012/4/29 1:00	0.0	0.0	0.1	6.1	6.1	6.4	65.1

Long-term trend of precipitation retrieved from the System

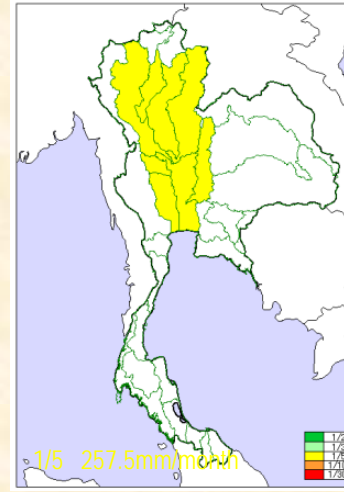
Retrieved monthly satellite-based precipitation from July to September, 2011



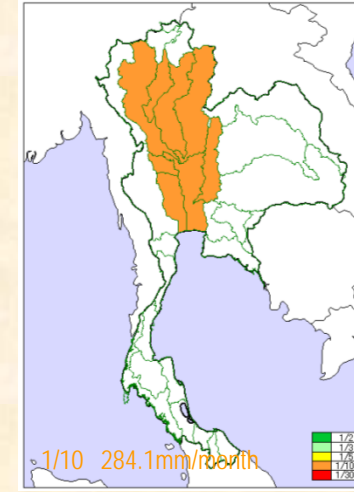
8/17 5:00
Monthly precipitation
exceeded 2-year return
period.



8/19 9:00
Monthly precipitation
exceeded 3-year return
period.



8/20 21:00
Monthly precipitation
exceeded 5-year return
period.



9/12 17:00
Monthly precipitation
exceeded 10-year return
period.

Satellite-based monthly precipitation exceeded 2-year return period in the mid-August, and 10-year return period in the mid-September.

5. Flood in the Yom River, September 2012

- ❑ *Passing **low-pressure brought about flash flood** in Sukhothai on September 8, 2012.*
- ❑ ***Dyke-break of the Yom River** occurred due to overtopping of floodwater on September 10, 2012, which resulted in inundation of as many as 1 meter depth.
(flood discharge : 1,500m³/s)*
- ❑ ***4 people was dead, and over 15,000 were affected.**
Total damage was estimated at least Bt 30 million.*
- ❑ *However, this flood was “nothing out of ordinary”, and **breached barrier was “in need of repair”, but not yet implemented.***

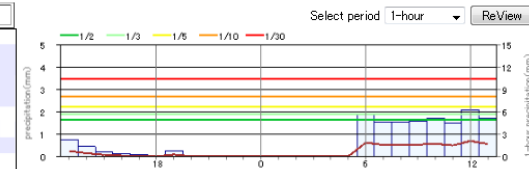
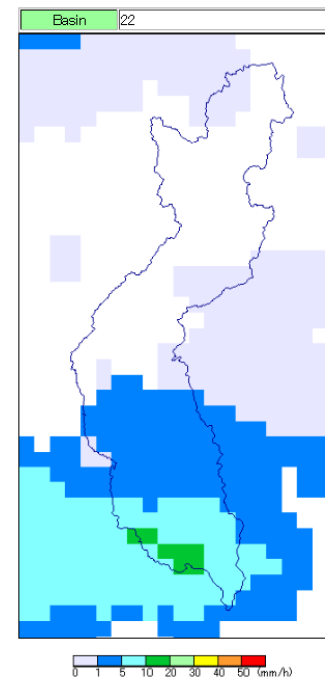
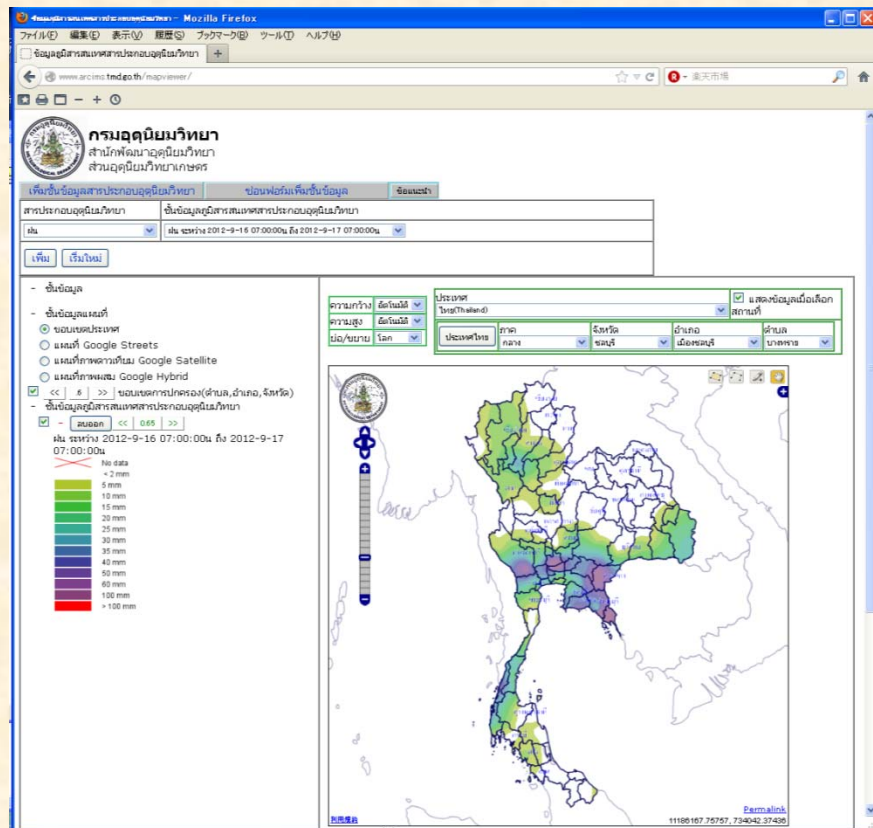
Flood situation in the Yom River



Source: TR weekly website

Precipitation data in the Yom River basin

Precipitation data in the Yom River basin can be acquired both from the Thai Meteorological Department (TMD) and from GSMP.



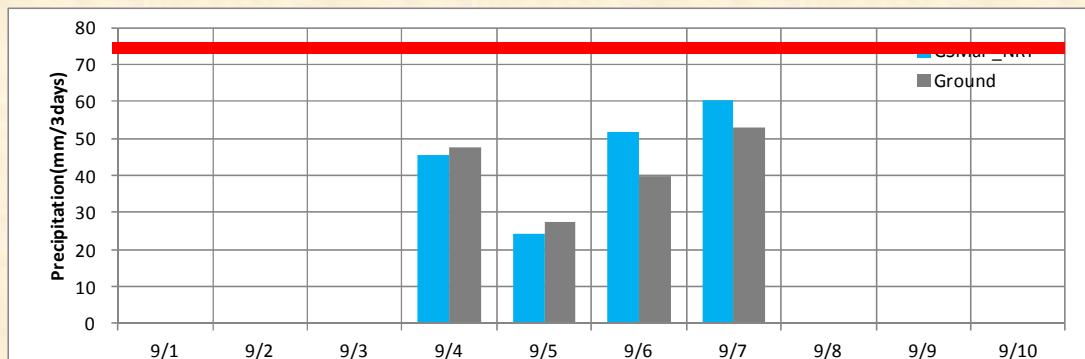
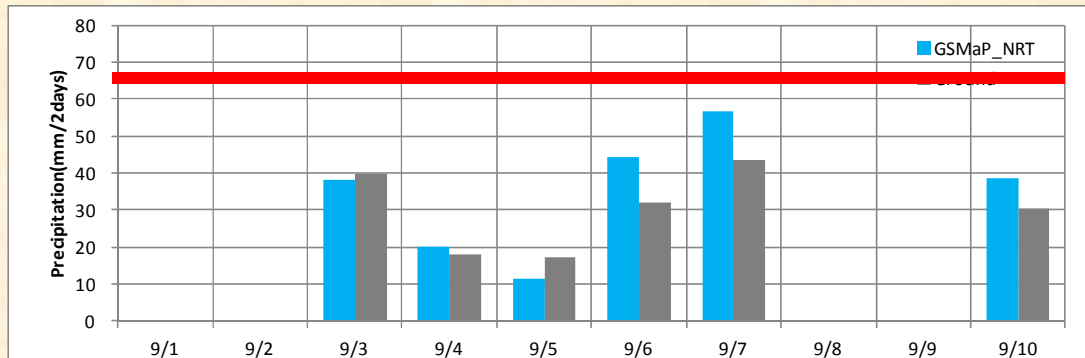
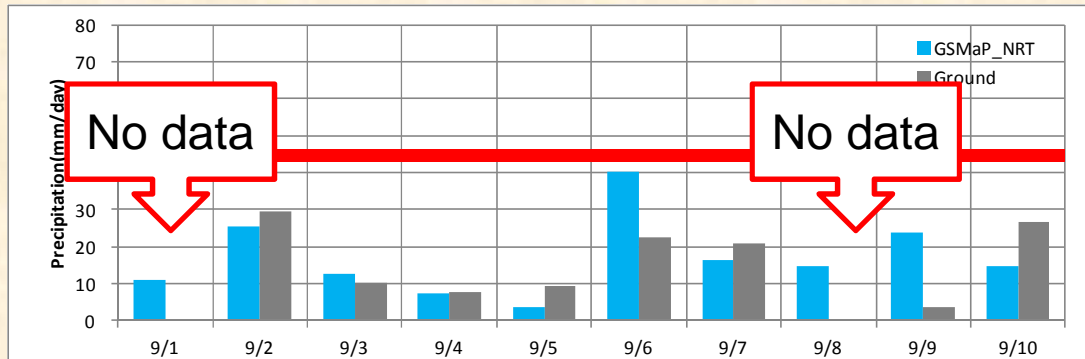
period precipitation(mm)							
period	1-hour	6-hours	24-hours	48-hours	72-hours	168-hours	720-hours
1/2	4.9	22.1	41.5	60.3	69.7	95.4	241.6
1/3	5.7	25.6	50.1	72.3	84.1	107.6	262.9
1/5	6.7	29.2	60.0	85.8	100.2	121.0	283.3
1/10	8.1	33.3	73.2	103.0	120.1	137.8	304.9
1/30	10.4	38.6	94.6	129.4	150.0	162.7	330.5

Basin average precipitation(mm)							
date	1-hour	6-hours	24-hours	48-hours	72-hours	168-hours	720-hours
2012/09/10 13:00	1.7	10.1	14.9	49.3	60.6	122.4	262.0
2012/09/10 12:00	2.1	10.0	14.0	47.9	61.6	121.0	268.4
2012/09/10 11:00	1.5	9.8	12.6	46.2	62.1	119.3	258.5
2012/09/10 10:00	1.7	8.3	11.9	44.9	62.0	118.0	257.2
2012/09/10 09:00	1.6	6.6	10.5	44.7	60.8	116.6	255.6
2012/09/10 08:00	1.6	5.0	11.4	44.2	59.4	115.3	254.1
2012/09/10 07:00	1.6	3.5	12.7	43.2	57.9	113.8	252.6
2012/09/10 06:00	1.9	1.9	13.9	42.0	56.5	112.3	251.2
2012/09/10 05:00	0.0	0.1	14.5	40.1	54.7	110.5	249.3
2012/09/10 04:00	0.0	0.1	16.5	40.1	54.9	110.8	249.3
2012/09/10 03:00	0.0	0.1	18.0	40.1	54.9	111.3	249.3
2012/09/10 02:00	0.0	0.1	19.2	40.0	55.0	111.9	249.3
2012/09/10 01:00	0.0	0.2	19.8	40.0	55.2	112.9	249.3
2012/09/10 00:00	0.0	0.4	22.1	40.0	55.4	114.4	249.3
2012/09/09 23:00	0.0	0.4	25.1	40.1	55.6	117.9	249.3
2012/09/09 22:00	0.0	0.5	28.2	40.2	56.0	121.3	249.3
2012/09/09 21:00	0.0	0.6	30.3	40.1	56.2	124.9	249.4
2012/09/09 20:00	0.0	0.8	32.1	41.0	56.5	128.9	249.5
2012/09/09 19:00	0.3	1.2	33.4	41.5	56.9	132.9	249.5
2012/09/09 18:00	0.0	1.6	34.0	41.6	56.9	135.5	249.3
2012/09/09 17:00	0.1	2.3	34.6	41.8	57.4	136.0	249.5
2012/09/09 16:00	0.1	3.0	34.8	42.3	60.9	136.2	249.6
2012/09/09 15:00	0.2	3.3	34.8	43.0	65.9	136.6	249.6
2012/09/09 14:00	0.5	5.5	34.7	43.7	71.3	137.0	249.4
2012/09/09 13:00	0.7	7.9	34.3	45.6	77.4	137.3	249.1

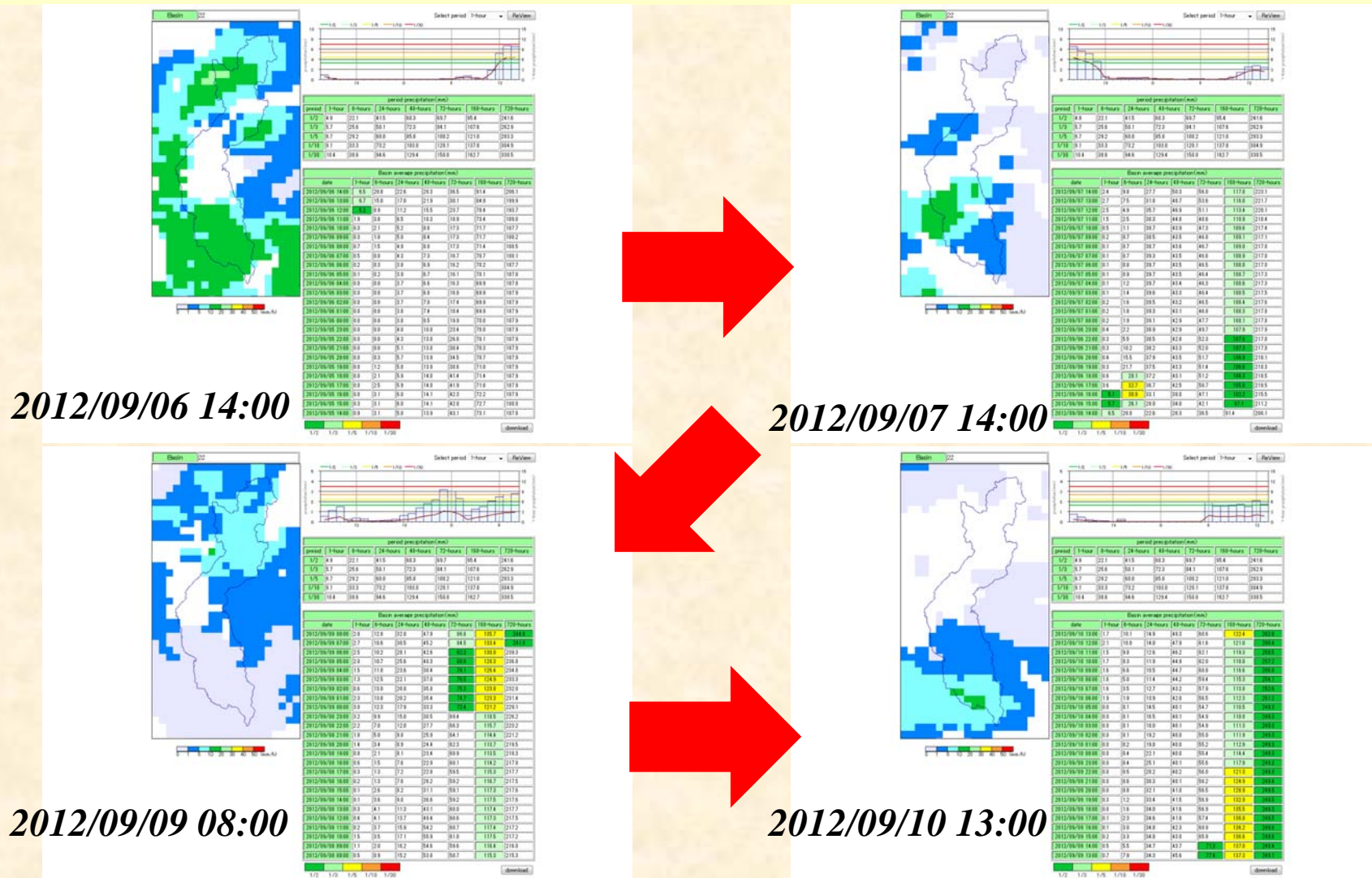
1/2 1/3 1/5 1/10 1/30

download

Comparison of the ground observation data and satellite monitoring precipitation data

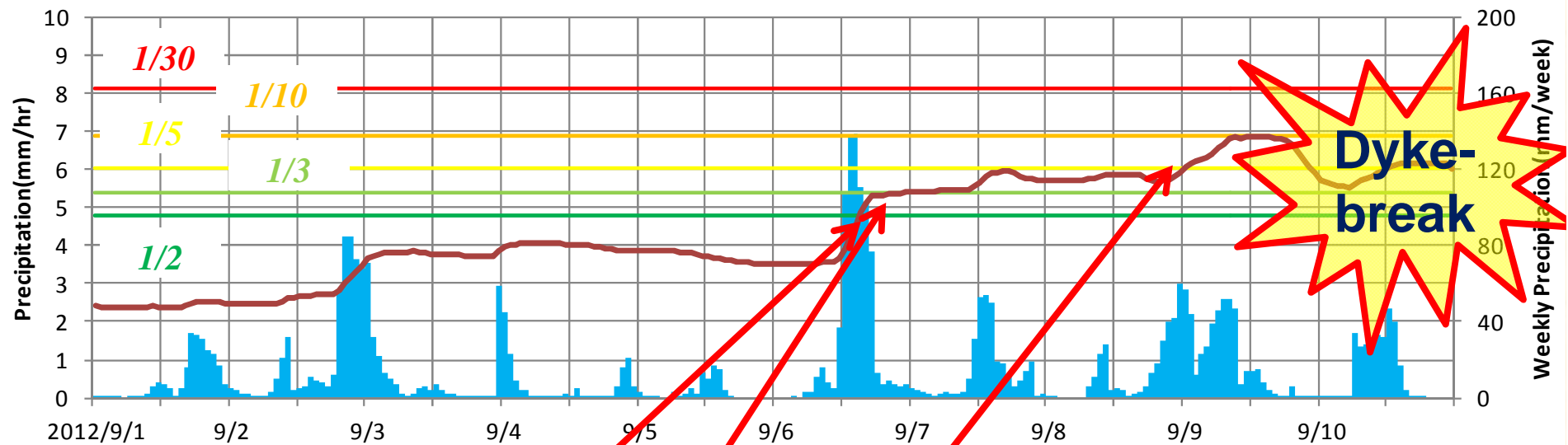


Retrieved precipitation data from the System



Before the dyke broke on September 10, the system indicated the long-term precipitation (3-days, 7-days) already reached to the critical level (1/3-1/5).

Satellite-monitoring precipitation in the Yom River basin



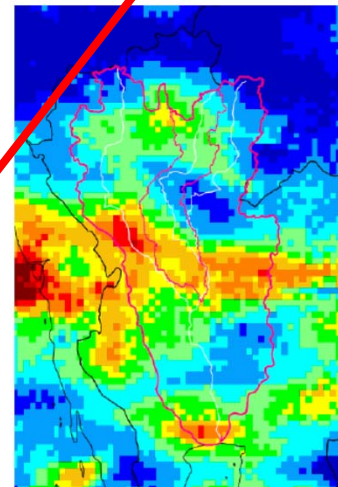
Satellite Data/ GSMPaP_NRT
Ground Data/ TMD

9/6 15:00
Weekly precipitation exceeded
2-year return period.

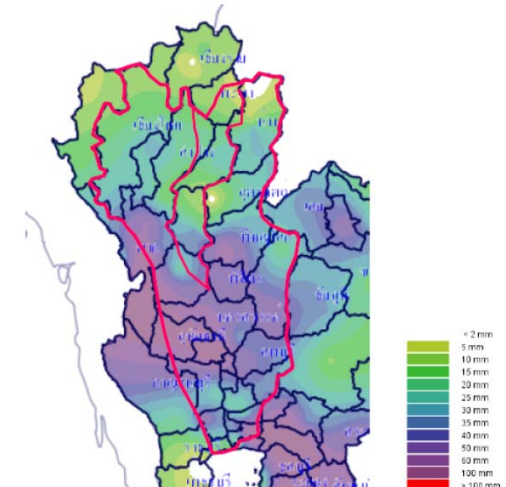
9/6 22:00
Weekly precipitation exceeded
3-year return period.

9/9 00:00
Weekly precipitation exceeded 5-year return period, still went up to
almost 10-year return period.

2012/9/6



GSMPaP_NRT
40.3 mm/day



Ground
22.6 mm/day

6. Findings from the comparison

- *Although precipitation of 1-3 days was relatively small (less than 1/ 2 years), precipitation trend/ pattern was found quite similar. And **trend/pattern of 3-days precipitation was much more similar.***
- *While ground observation system is surely essential for adequate flood forecasting and warning, **satellite monitoring precipitation can supplement & support flood management** where ground observation network is scarce.*
- *The System retrieved that **the weekly-precipitation exceeded 1/5 years** on September 9, which was **just one day before the dyke actually broke.***
- *This means **the flood disaster could have been foreseen** by checking the satellite precipitation from the System.*

6. Conclusion

- Ground observation need lots of time and huge cost for installation, therefore satellite-monitoring precipitation can supplement and support flood management (warning and forecasting).
- GFAS can be applicable with good accuracy to relatively large-scale river basin and for long-term prediction.
- Still they need to develop and improve, so we want to invite more countries/ organizations to participate in our activities.
- Recent progress includes the development of Satellite-Based Precipitation Data Delivery System for Thailand.
- By using this System, Chao Phraya flood in 2011 and Yom River flood in 2012 can be retrieved, which suggests the System provide useful information for the flood management before actual flood disaster occurs.

*Thank you very much
for your attention*

Please contact to 2bu01@idi.or.jp:

IFNet: <http://www.internationalfloodnetwork.org>

GFAS: <http://gfas.internationalfloodnetwork.org/n-gfas-web/>