New Concept of Regional Cooperation in Asia for Water Disaster Management Applying Satellite Precipitation Measurement

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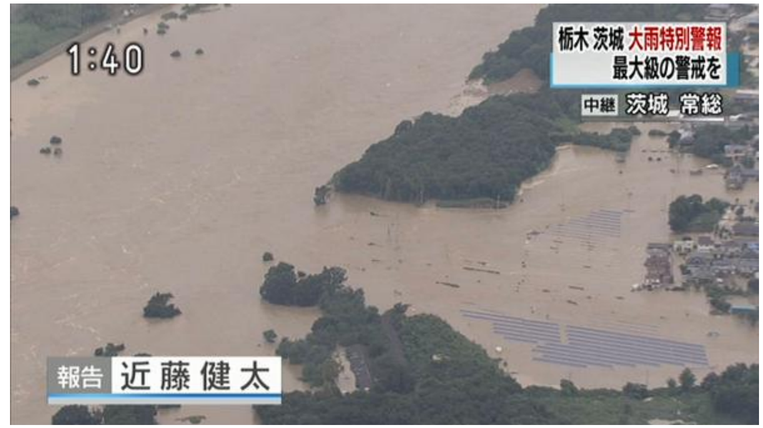
Rainfall Data Collection is Essential to Mitigate Disaster Damages

Flood happened 5 major rivers and 80 rivers.

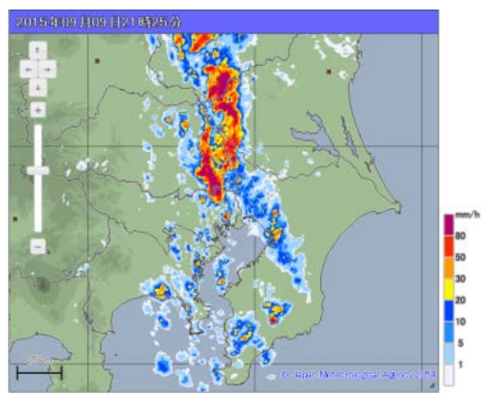


Historical heavy rain (>300mm/day) in Kanto and Tohoku region of Japan on September 9-11, 2015,

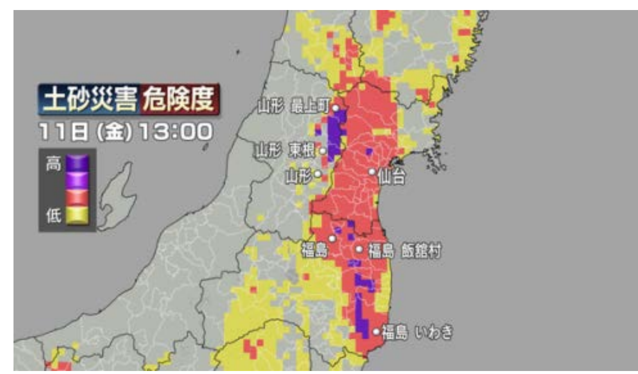
Caused severe damages

- 8 people dead
- 75 houses colapsed
- 3851 houses damaged

Rainfall information played an essential role to mitigate damages of heavy rain.



Rainfall distribution information



Landslide risk information

Different Methods to Collect Rainfall Data

Ground rain gauge

- Best accuracy
- Easy to collect real-time data
- **Only pin point data**
- **Lot of gauges are needed**

Ground precipitation radar

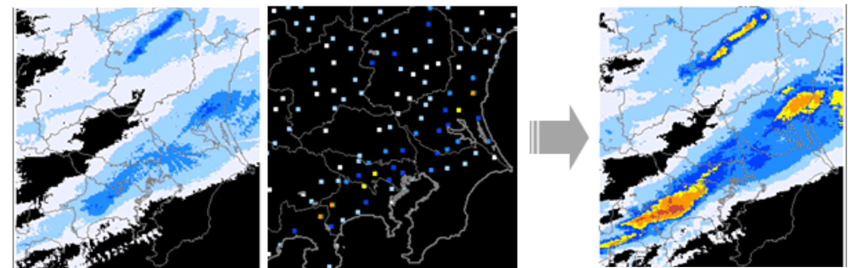
- Collect distributional data
- Cover large area (several hundreds km)
- Has an error (need to calibrate with rain gauges for qualitative use)
- Easy to collect real-time data
- **Expensive to cover whole country**
- **High intainance and operational cost**
- **Difficult to calibrate data**

Satellite precipitation measurement

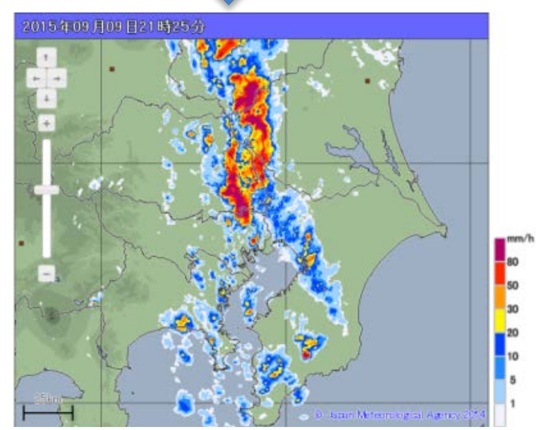
- Can collect distributional data
- Can cover large area including ocean, other countries and mountenous areas
- Calibration is easier (satellite radar)
- Has an error (need to calibrate with rain gauges for qualitative use)
- Minimum about 1 hour delay to collect data
- Expensive to build
- Maintainance and operational cost is high

Integration of different data

Radar Data | Rain Gauge Data | Analysed Data



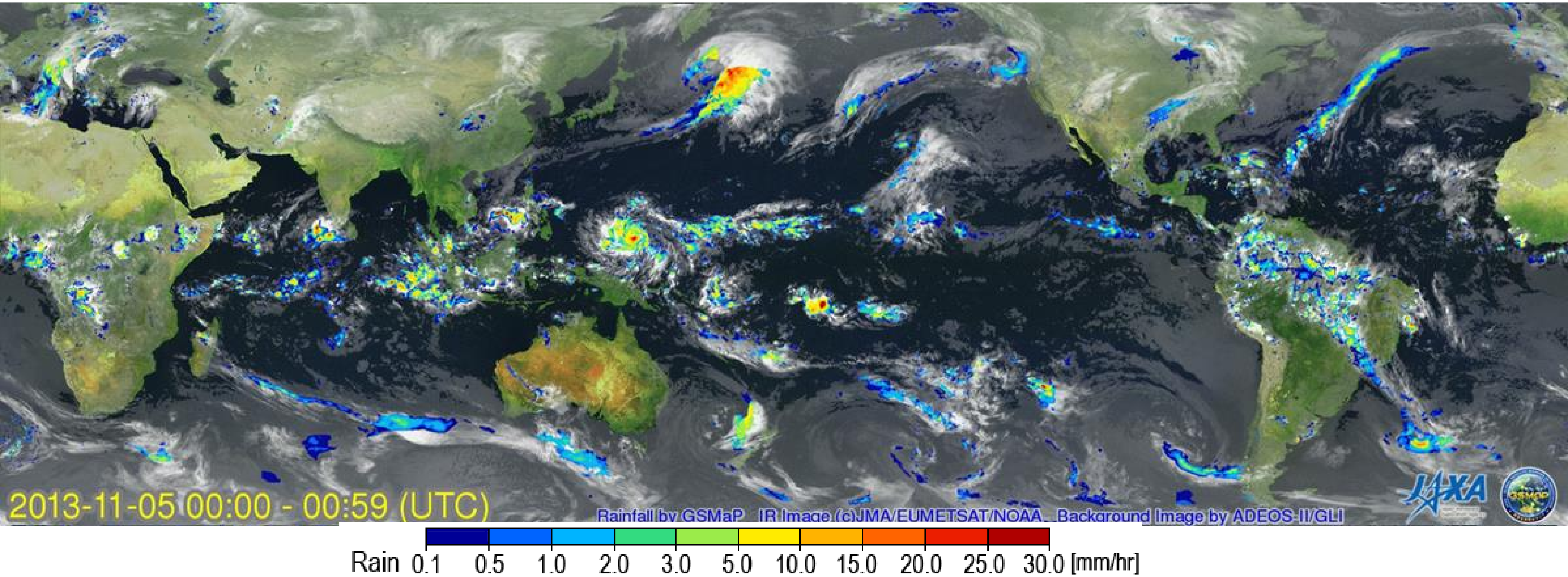
Distibutional Data | Accurate Pinpoint Data | Accurate Distibutional Data



Radar Nowcast operated by Japan Meteorologocal Agency (JMA)

Some images are from JMA

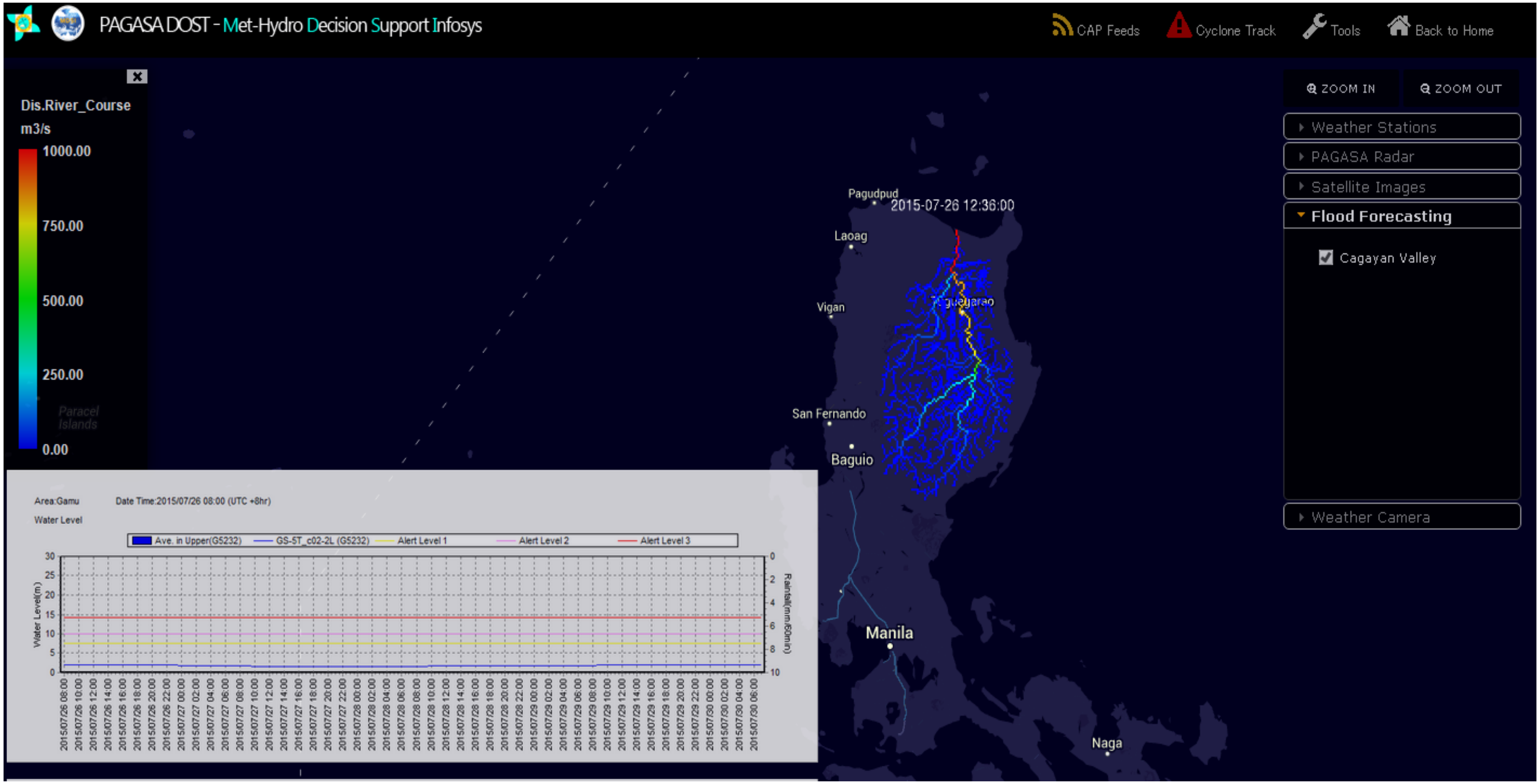
Global Satellite Mapping of Precipitation



GSMaP: Global Satellite Mapping of Precipitation

- JAXA's Free satellite-based rainfall data
- Hourly data (0.5 hour or 4 hour after observation)
- 0.1 deg x 0.1 deg grid (around 10km grid)
- Archive data for more than 10 years.
- Available from JAXA G-portal (https://www.gportal.jaxa.jp) as well as current GSMaP web site (http://sharaku.eorc.jaxa.jp/GSMaP/).

GSMaP Application for Flood Management



Integrated Flood Analysis System (IFAS) introduced to Cagayan River Basin in the Philippines and operated by Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)

Current Challenges for Applying Rainfall Data

A) <u>Observation</u>

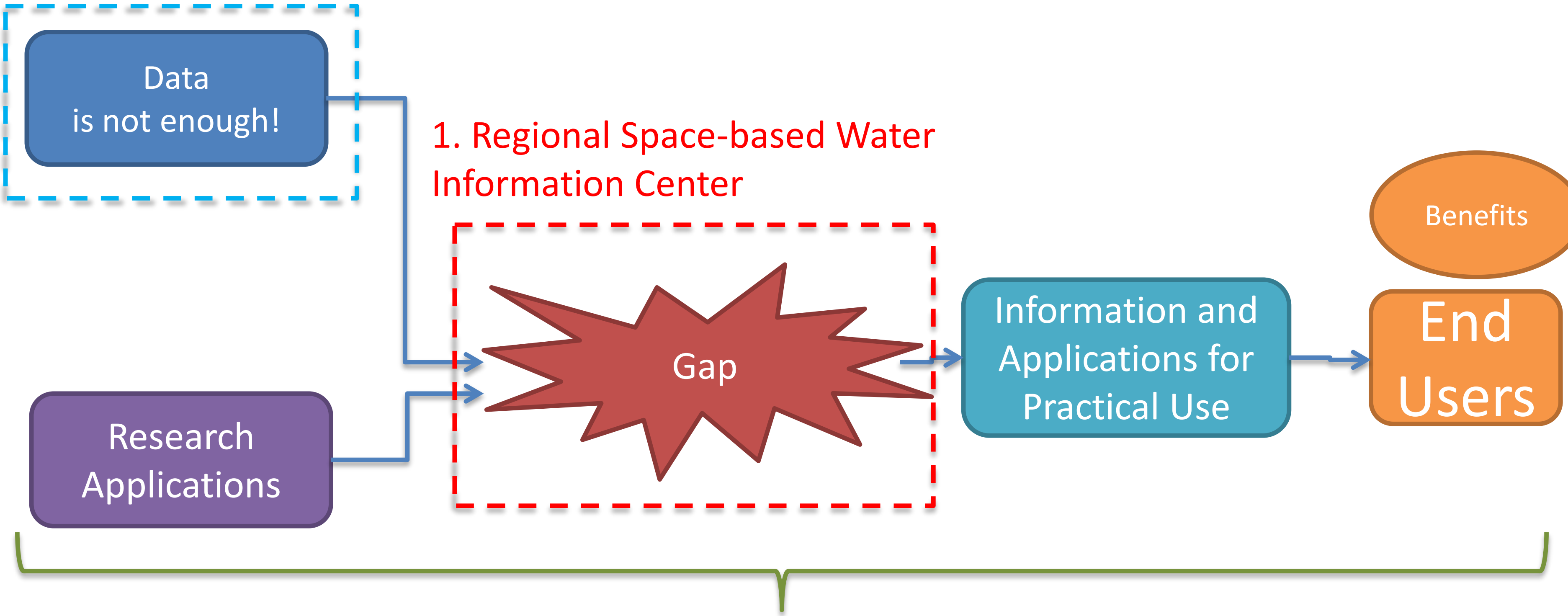
- Limited coverage due to lack of enough ground sensors
- Difficulty in operating the radar in sustainable manner
- Lack of continuous archive of data

B) <u>Application and Utilization</u>

- Lack of reliable data for practical use
- Lack of resources (funding, capacity, etc.) to introduce applications
- Lack of communication between data providers/application developers and practical users
- Insufficient market size for private companies to sustain business in application fields

Three possible approaches

3. Strengthening observation by combining ground gauges, radars and satellite observation



Lack of capacity, lack of resources

2. Development Asistance Package by donors for Water-related Issues

Contents

Key points

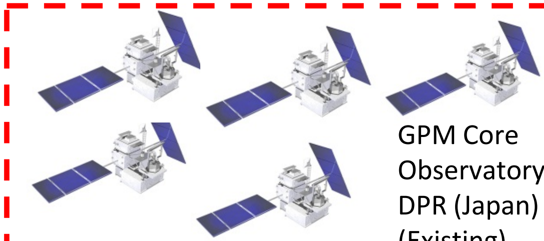
1. Combining improved satellite rainfall data with existing ground sensors

2. Bridge the gap of research activities and practical applications.

3. Involvement of more countries in AP region.

(Draft Idea) Asian Space and ICT-based Water Issues Management Program (ASIWIMP)

1. **Establishment of "Asian Satellite Water Information Center (ASWIC)" by Asian countries with support from international development agencies.**
2. **Establishment of "Asian Precipitation Radar Constellation (APRC)" by Asian countries**
3. **Implementation of Official Development Assistance (ODA) project for water issues management in selected developing countries in Asia**



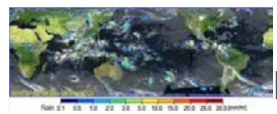
GPM Core Observatory/ DPR (Japan) (Existing)

2. Asian Precipitation Radar Constellation by Asian Countries (ODA in each country)

Contribution to GEOSS

Global Precipitation measurement（GPM） program（Existing）

Other Satellite data such as Himawari-8



Improved Satellite Precipitation Data (GSMaP)

IFAS Research Applications and Systems, etc.

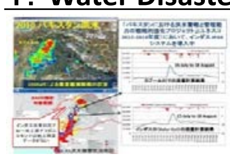
1. Asian Satellite Water Information Center(ASWIC)

- Develop practical applications based on available ground/satellite data for water issues management
- Funding from internatinational development agencies
- Support introduction of the practical applications by providing capacity development program.

Practical Applications

3. Ground Component(ODA in each country)

1．Water Disaster Management



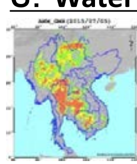
Flood Forecasting Model (IFAS, etc.)

Land Slide Risk Model

2．Meteorology

Weather Forecast Model

3．Water Resources Management



Drought Model

Water Cycle Model

Establishment of Data sharing network of existing ground sensors.

Dissemination

Conventional methods + Cell phone messages, etc.

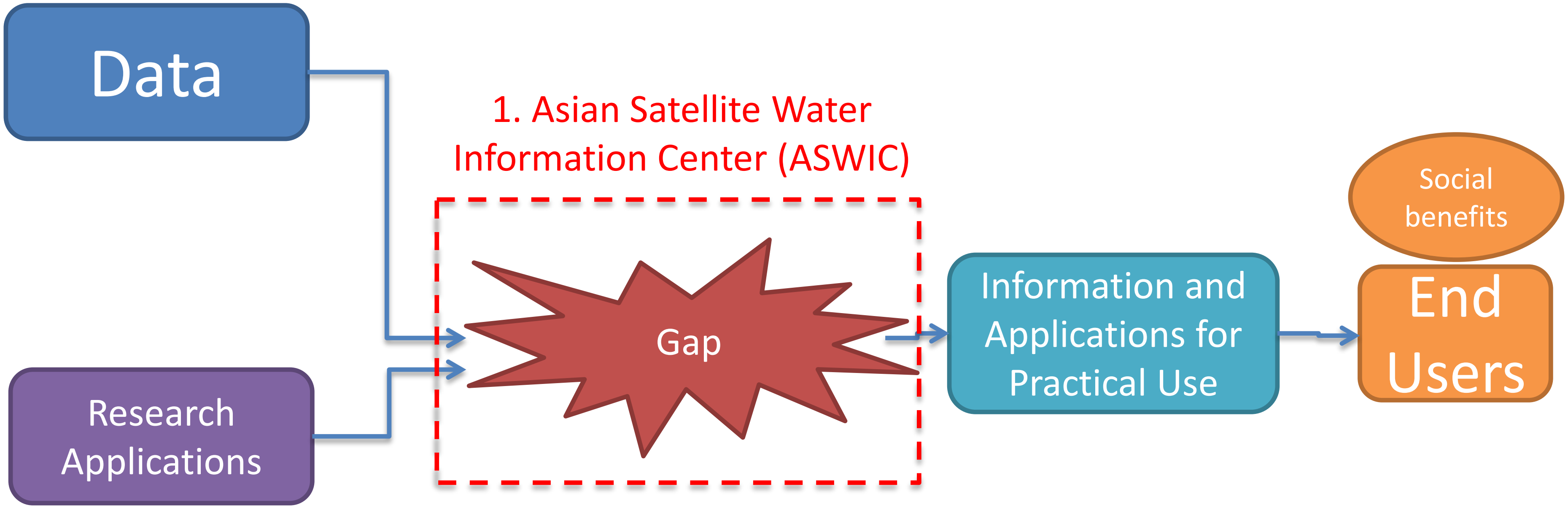
Action

Evacuation drill, etc.

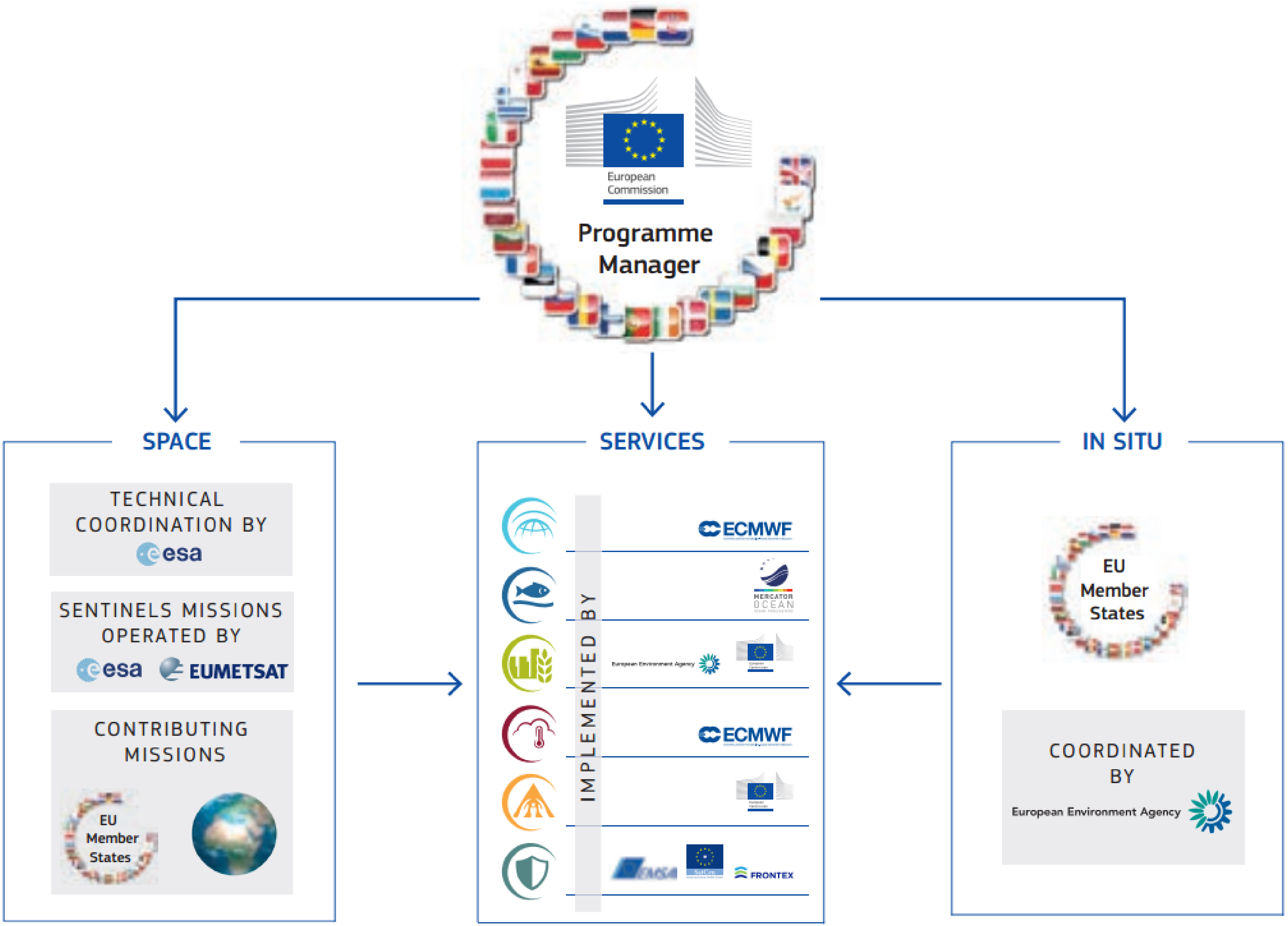
Infrastructure

Evacuation Shelters, etc.

Big gap between data/research applications and practical applications/social benefits



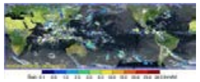
Example of EU's Copernicus Program to bridge data and services



http://www.copernicus.eu/sites/default/files/documents/Brochure/Copernicus_Brochure_EN_WEB.pdf

Draft idea of Asian Satellite Water Information Center (ASWIC)

Satellite Data



GSMaP

Other satellite data such as Himawari 8

Ground Data

From agencies in each country

Research Applications

IFAS DIAS

Other available aplications and models

Asian Satellite Water Information Center (ASWIC)

- Provide satellite-based sollutions for water issues to strengthen capacity of Asia-Pacific region to collect and apply water information
- HQ: TBD
- Staff: Seconded from each country+Contract-based+ administrative support from host country
- Funding(TBD) : From international development agencies and contribution of member countries

Meteorology Team | Water Resources Team | Water Disaster Team | Secretariat

Activity1: Data Collection and Process

Data collection,
Calibration of GSMaP with ground gauges,
Integration of GSMaP and Ground radar data

Activity3: Knowledge Center

Workshops, etc.

Activity4: Capacity Building, Technology Transfer

Activity5: Support for introduction of the developed applications

Introduction of the practical applications through technical assitance projects.

Activity2: Development of practical applications, Provision of information for water issues management

"Regional" applications

Asian satellite water information system

Individual Applications

Development of practical interface of systems such as IFAS

Information for Water Issues Management

Provision of information
・Water resources risk maps
・Information of suitable areas for irrigation, etc.

* To fill the gap between search apps and practical applications

Social Benefits

Users

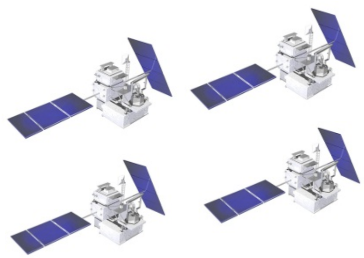
Org. in each country

International Organizations

Capacity Building

Providing Services

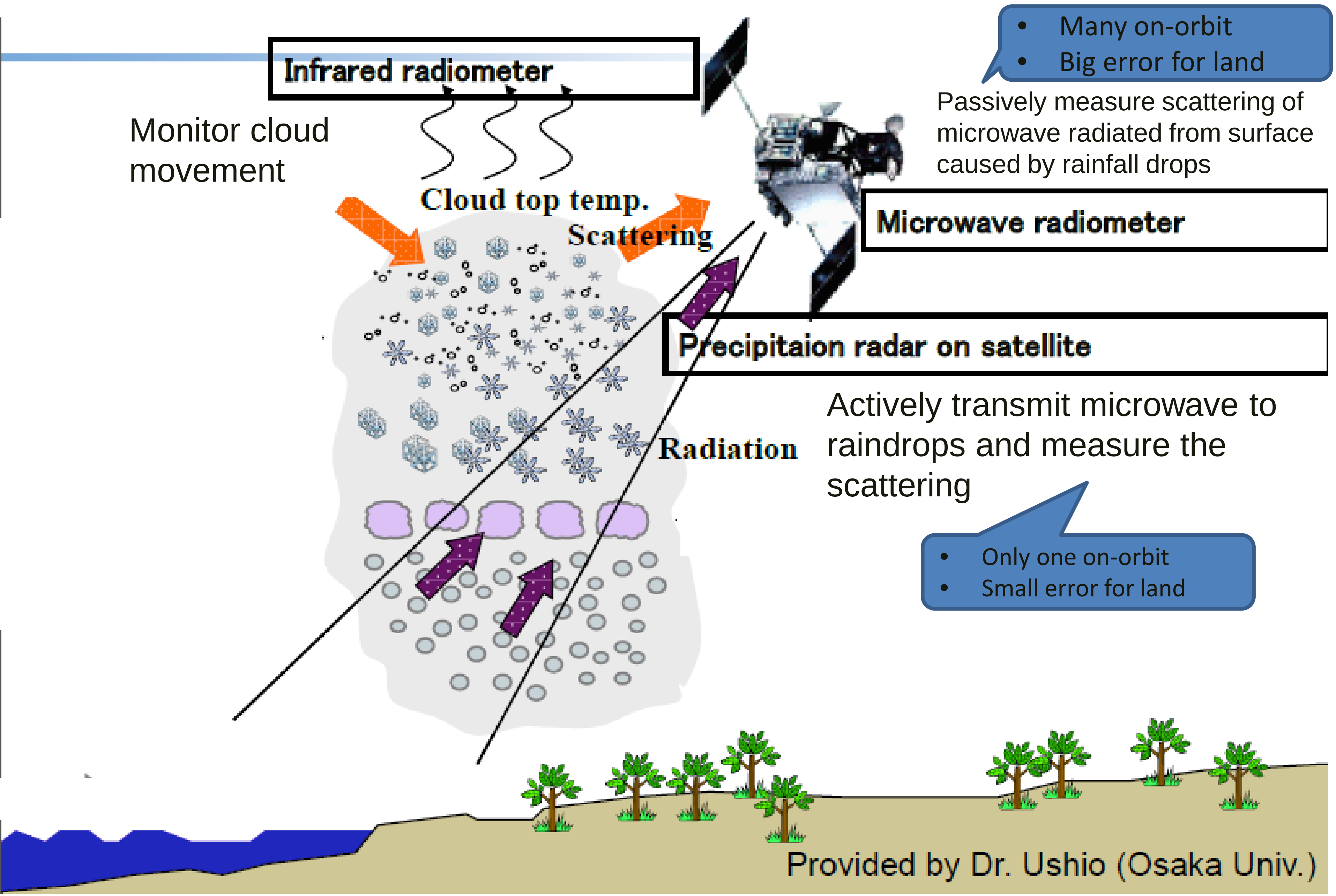
[Concept] Asian Precipitation Radar Constellation (APRC)



Asian Precipitation Radar Constellation (APRC)

[Small Satellite Precipitation Radar Satellite]

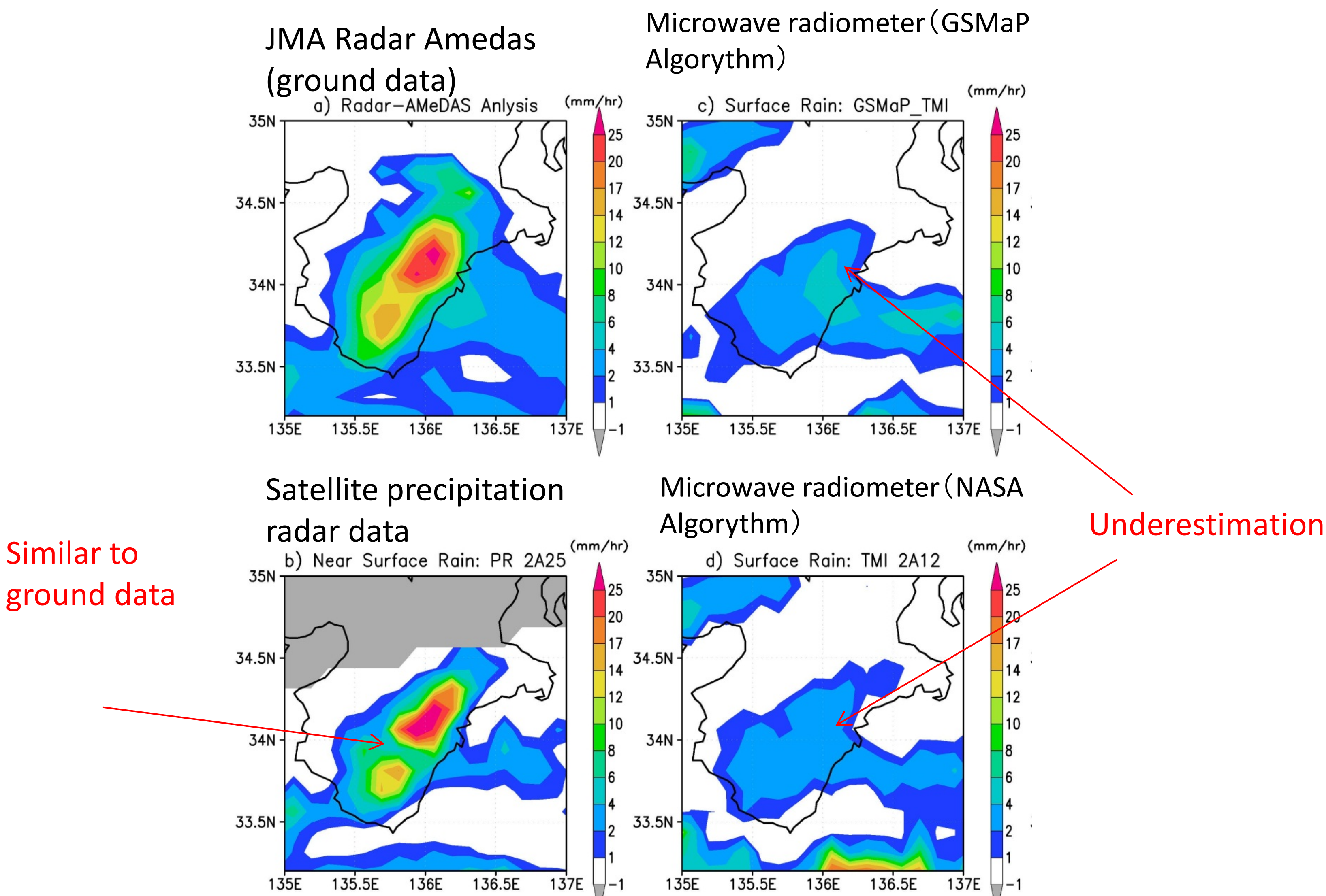
- Satellite with small precipation radar (13.6GHz, Ku band)
- Orbit :
  - Altitude: 600 km
  - Inclination: 30 deg
- Weight: Less than 600kg
- Lifetime: more than 5 years
- Output data: precipitation data
- Swath Width: about 600 km
- Spatial resolution:
  - Along track about 10 km
  - Cross track about 12 km (Nadir), 16 km (Swath edge)
- Minimum detectable rain rate: about 1mm/h
- 4-6 times observation/day with 4 satellites



Infrared radiometer
Monitor cloud movement
Cloud top temp.
Scattering
Many on-orbit
Big error for land
Passively measure scattering of microwave radiated from surface caused by rainfall drops
Microwave radiometer
Precipitaion radar on satellite
Radiation
Actively transmit microwave to raindrops and measure the scattering
Only one on-orbit
Small error for land
Provided by Dr. Ushio (Osaka Univ.)

Good accuracy on land of Satellite radar

Heavy rain in Kii Peninsula in Japan, July 30, 2014 (Kubota et al. 2009)



Examples of Earth Observation Satellite Program in Emerging Space Countries

- Viet Nam: VNREDSat-1A, 120kg, $75.5m
- Indonesia: LAPAN A2, 75kg, $3.5m
- Thailand : THEOS, 750kg, $160m
- Malaysia: RazakSAT, 187.6kg, $50m
- Nigeria: NigeriaSat2, 270kg, $45m
- Turkey: BilSat-1, 130kg, $45m

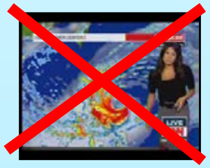
Benefits of the Program: Before/After

Before

Insufficient Ground Rainfall Measurement Network

- Insufficient coverage of ground rain gauges and ground weather radars
- Insufficient calibration of ground weather radars
- Long time for recovery for damages by thunders and typhoons
- Stop operation during dry seasons for electricity saving
- Observed data is not archived and shared

No information of rainfall distribution for weather monitoring and forecast



Cannot introduce reliable flood model

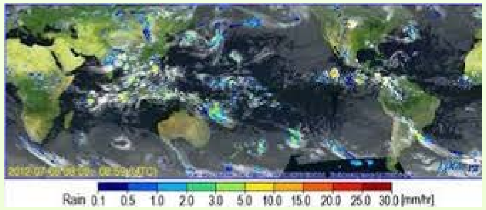
Short lead time with conventional forecasting method using upstream measured water level

Ineffective water resources management, climate change adaptation

Long term rainfall data necessary for run water cycle models, etc. has not been recorded

After

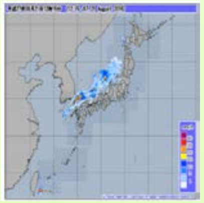
Application of Hourly Regional Rainfall Map



*Existing GSMaP is based on microwave radiometer measurement, which doesn't have good accuracy on land. By increasing frequency of sastellite radar measurement, the quality of GSMaP will dramatically increase, which will increase the accuracy of flood models, etc.

- Effective use of existing ground weather radars
  - Calibration of ground radars by satellite precipitation radars
- Supplement of existing ground weather radars
  - Satellite observation for the area where ground radars can't cover (area without radars, ocean, mountains)
  - Uniform, continuous data collection by satellites
- Integration of ground rain gauges, ground radar and satellite rainfall data

Contribution to improvement of weather monitoring and forecast and climate sciences

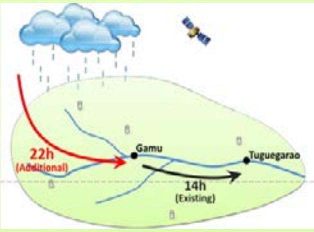


- Application fo distributional rainfall data to weather monitoring and forecast
- Assimilation to numerical weather forecast models and short term weather forecast by understanding of rainfall movemnet
- Application of data by citizens using systems such as mobile phone apps.

Water resources management and climate change at regional level

- Application f collected long term rainfall data to water cycl emodels and drought models for policy making and daily buiness
- Regional level measures will be taken by understanding of climate change impact in the region

Damage mitigation by more reliable flood models



- Extension of lead time of flood forecast to mitigate damage of floods by having more time for evacuations, etc.

Established collaborative framework between user agencies and space agencies

- It was difficult to mantain and manage introduced system under conventional ODA projects conducted only with operational agencies.
- It is possible to operate systems and expansion by R&D with involvement of space agencies in charge of technlogy development.

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2. New Ideas
3. Conclusion

Conclusion

- Asian Space and ICT-based Water Issues Management Program (ASIWIMP) consisting of the following would be effective to fight against water issues in Asia and the Pacific
  1. Asian Satellite Water Information Center (ASWIC)
  2. Asian Precipitation Radar Constellation (APRC)
  3. Official Development Assistance (ODA) project for water issues management

- JAXA Mission planning department would like to discuss this idea with other countries to make it more effective and feasible plan.