Japan’s Experiences on Multi Hazard Early Warning System

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The First Regional Workshop on Multi-Hazard Risk Assessment and Early Warning Systems by Using Space and GIS Applications
Nadi, Fiji, 13-15 September 2016
1. Sentinel Asia
Background of Sentinel Asia

Asia has been seriously damaged by natural disasters over the last 30 years (1985-2014).


- **Occurrence**
  - Asia: 3,949
  - World: 10,319

  38%

- **Damage**
  - Asia: 1,226,204 millions US$
  - World: 2,562,390 millions US$

  48%

- **Killed**
  - Asia: 1,171,945
  - World: 1,942,334

  60%

- **Affected**
  - Asia: 5,294,962,652
  - World: 5,905,233,727

  90%
Sentinel Asia

Sentinel Asia is a voluntary initiative by a collaboration between space agencies and disaster management agencies, applying remote sensing and Web-GIS technologies to assist disaster management in the Asia-Pacific region.

Oct 2005, Asia Pacific Regional Space Agency Forum (APRSAF-12)
Kitakyushu, Japan
The plan to initiate the pilot project was approved.
http://www.aprsaf.org/data/aprsaf12_data/day3/5_sswg%20sumrepo.pdf

In Feb 2006, Joint Project Team (JPT) was organized and Sentinel Asia has started.
Sentinel Asia is the first initiative under APRSAF.

http://sentinel.tksc.jaxa.jp/
Vision of Sentinel Asia

• Sentinel Asia is an initiative proposed and supported by APRSAF

• Contribution from space community (APRSAF) to disaster management in the Asia-Pacific region by applying space and ICT technologies

• Collaboration between space agencies and disaster management agencies

• Voluntary initiative by participating organizations for humanitarian purposes
Framework of Sentinel Asia

**Sentinel Asia**

*Joint Project Team (JPT)*

Join Project Team consists of total 102 organizations including 87 organizations of 26 countries/region and 15 international organizations as of August 2016. JAXA is the secretariat of JPT.

*APRSAF*  
Data Provision  
Promotion of Utilization  
Capacity Building

*ADRC**  
Member Countries  
Utilization (User)

* Asian-Pacific Regional Space Agency Forum  
** Asian Disaster Reduction Center

International Community

UN / ESCAP  UN / OOSA  ASEAN  AIT  etc.

International Cooperation

JPT meeting at Colombo, Sri Lanka in Jan 2016
ADRC Members Countries

- Armenia
- Azerbaijan
- Bangladesh
- Bhutan
- Cambodia
- China
- India
- Indonesia
- Iran
- Japan
- Kazakhstan
- Kyrgyz Republic
- Lao PDR
- Malaysia
- Maldives
- Mongolia
- Myanmar
- Nepal
- Pakistan
- Papua New Guinea
- Philippines
- Republic of Korea
- Russian Federation
- Singapore
- Sri Lanka
- Tajikistan
- Thailand
- Uzbekistan
- Viet Nam
- Yemen

Advisor Countries
- Australia
- France
- New Zealand
- Switzerland
- U.S.A

see http://www.adrc.asia/disaster/index.php
Concept of Sentinel Asia Step 1

Observation System

Capacity Building

Disaster Management Agencies

Archived Data Observation Data

Information Sharing Platform

Digital Asia

Data

Residents in disaster areas

Warning Refuge Rescue
Concept of Sentinel Asia Step 2

**Observation**
- Space Agency
- Earth Observation Satellite
- Value-added Information
- Disaster Information

**Utilization**
- Communication Satellite
- Transmission
- Disaster Management Organization
- User Expansion
  - Governmental Organization (ADRC members)
  - Local Governmental Organization

**Sharing (Web)**
- Human Network
- Capacity Building • Outreach

**End User**
Concept of Sentinel Asia Step 3

Positioning satellites

Earth observation satellites

Communication satellites

Information delivering to personal terminals

Monitoring

Information/data transmission

Pre-disaster
Mitigation: Community education
Preparedness: Hazard map
Early warning system

Just after disaster
Response: Emergency observation

Post-disaster
Recovery: Monitoring

Disaster information

Information sharing (Web-GIS)

Human network
Capacity Building, Outreach
Data Sharing on Web-GIS in Sentinel Asia Step 2 System

**Sentinel Asia Step2 System**

- **Data Provider Node (DPN)**
  - JAXA, ISRO, GISTDA, KARI, NARL
- **Data Analysis Node (DAN)**
  - AIT, ADRC, ICIMOD, LAPAN, MONRE, CRISP, CEA, CAIAG, NCSRT, Sri Lanka MoDM, BPPT, MO, etc.

**Satellite Data**

**Users**
- Public
- JPT Member
- ADRC Member

**EO Request**

**Information using Web-GIS**

**Own Data**
- such as Map, Satellite Data

**Analyzed Products**

**Textual Content**

- **Satellite Data**
- **JPT Member ADRC Member**

- **Information using Web-GIS**
  - Own Data

- **Sentinel Asia Step2 System**
  - http://sentinel.tksc.jaxa.jp/

- **Data Sharing on Web-GIS**

- **Users**
  - Public
  - JPT Member
  - ADRC Member

- ** EO Request**

- **Information using Web-GIS**

- **Own Data**
  - such as Map, Satellite Data

- **Satellite Data**

- **Data Provider Node (DPN)**
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Improvement of Accessibility to Information
Data Transmission to Regional Servers by WINDS

Central Server (Japan)
http://sentinel.tksc.jaxa.jp/

Data Provider

Internet Access System

Internet Access

Narrow Band

Data Transmission via WINDS

Regional Server

Regional Server

Regional Server

Internet Access to Regional Server

Bangkok: http://sentith1.eoc.gistda.or.th/
Manila: http://sentiph1.asti.dost.gov.ph/
Fire Detection

SATREPS JICA/JST Project (2009-2014)

Observation by Satellites

Fire Detection and Control System

Wildfires in Parangka Raya, Kalimantan

Operation at LAPAN in Jakarta

Fire Information via SMS to Firefighters

Project for wildfire and carbon management in a peatland in Kalimantan, Indonesia organized by Hokkaido University under the framework of the SATREPS

Ground Water Level Estimation

Firefighters
GLOF Early Warning System in Bhutan

based on community cooperation in Mo River basin, Bhutan
by ADRC and Ministry of Home and Cultural Affairs

• Creating map with elevation data in upstream area of the Mo River and hazard map based on past flood records in Punakha

• Capacity development on community level: disaster education and training among local residents

• To install community-based river level gauges, and develop early warning system

Flood water level of the Mo River in 2009

Public awareness workshop on GLOFs and earthquakes in Punakha in February 2012, quoted from ADRC Highlights Vol. 229, http://www.adrc.asia/highlights/NewsNo229
Capacity Building and Human Network

A good human network is the foundation of the project

The 7th Sentinel Asia System Operation Training by JAXA, hosted by ICIMOD in February-March 2011

The 6th Sentinel Asia System Operation Training by JAXA, hosted by GISTDA in July 2010
TRAINING FOR IMMEDIATE ACCESS AND EFFECTIVE UTILIZATION OF SATELLITE INFORMATION FOR DISASTER MANAGEMENT

- Introduction to How to Use Sentinel Asia System
- How to Request Emergency Observation
- Basic Principle of Optical and SAR
- Case Study of Satellite Data Utilization
- Hands-on Training of ALOS Data Visualization and Analysis (Optical and SAR)
- Analysis of disaster affected area and damages from SAR data Utilization and ways of obtaining commercial satellite data
- Emergency Operations of Satellite Image Analysis and Data Distribution for Disaster Response
- Methodology of SAR Image Interpretation
- Field trip for SAR Image Interpretation
- Hands-on training of Rapid Flood Mapping using pre- and post-disaster SAR images
- Overview of PDNA (Post Disaster Need Assessment) with satellite images
- Hands-on training of GIS and satellite data utilization for PDNA

JICA/ASEAN Training (2013-2015)
November 2013, August 2014 at Jakarta, Indonesia
Emergency Observation and Data Transmission via WINDS

- **WINDS (Japan)**
- **ALOS (JAXA)**
- **IRS (ISRO)**
- **THEOS (GISTDS)**
- **KOMPSAT (KARI)**
- **FORMOSAT (NARLabs)**
- **XSAT (CRISP)**

Data transmission via WINDS

Central Server in Japan

Regional Servers mirroring Central Server in 11 countries

Users

Earthquake

Volcano eruption

Tsunami

Earthquake

Flood

Wildfire
Emergency Observation Flow

1. **Disaster Occurrence**
2. **Requesting Organization (RO)**: ADRC members, JPT members
3. **Desaster Management Agencies in Asia**
4. **International Disaster Charter**
5. **Data Provider Node (DPN)**
6. **Data Analysis Node (DAN)**
7. **Support**
8. **Sentinel Asia Step 2 System**

**Flow of Data:***
- ADRC members
- JPT members
- Emergency Observation Request, Disaster Info
- Disaster Info
- Displacement Images & Disaster Info
- Satellite Images & Disaster Info
- Emergency Observation Request
- Disaster Info
- Analyzed Products
- Archive Images
- Images by Emergency Observation
- Analyzed Products
Data Provider Node (DPN)
Sentinel Asia Constellation
contributing to Emergency Observations

ISRO
RESOURCESAT-2, OCEANSAT-2/OCM
IMS-1, CARTOSAT-1&2, RISAT-1

JAXA
ALOS-2

KARI
KOMPSAT-1

NARLabs

GISTDA

FORMOSAT-2

THEOS

CRISP

XSAT

VNREDSat-1A

VAST

KIBO HDTV-EF

escalation from Sentinel Asia

International Charter

THEOS
KOMPSAT-1

ISRO

RESOURCESAT-2, OCEANSAT-2/OCM
IMS-1, CARTOSAT-1&2, RISAT-1

JAXA

ALOS-2

KARI

KOMPSAT-1

NARLabs

GISTDA

FORMOSAT-2

THEOS

CRISP

XSAT

VNREDSat-1A

VAST

KIBO HDTV-EF

escalation from Sentinel Asia

International Charter
DPN member’s contribution
Sentinel Asia’s Contribution to Emergency Observation

EO temporal trends during 2000-2014. Number of activations and distribution among the different mechanism

Global 5-year totals of EO activations by world region. Parts of Asia and southern Europe have the largest increase in activation numbers in the past 10 years

reference:
http://science.sciencemag.org/content/353/6296/247
Data Analysis Node (DAN)
Framework of satellite data analysis to provide analyzed products

2 P-DAN
43 DAN (incl. 7 DPN)
2. GSMaP
DPR observed cyclone “Winston”
Global Precipitation Measurement (GPM)

GPM is an international mission consisting of the GPM Core Observatory and Constellation Satellites for high accurate and frequent global precipitation observation.

- Core Observatory: developed under NASA and JAXA equal partnership.
- Constellation satellites: provided by international partners (includes GCOM-W1).

Dual-frequency Precipitation Radar (DPR)
- developed by JAXA and NICT
- DPR is composed of two radars: KuPR & KaPR

GPM Core Observatory was successfully launched on 28 Feb. 2014 (JST).

All GPM standard products were released
We have started to release hourly global rainfall data (0.1x0.1deg. lat/lon) in near real time (about **four hours** after observations) and visualize the latest data quickly.

**Global Satellite Mapping of Precipitation (GSMaP)**

produced 4 hours after observation and updated every hour

Internet access
- Images & Movies
- Google Earth files
- Data download

http://sharaku.eorc.jaxa.jp/GSMaP/
GSMaP Cyclone Winston

Cyclone Winston from 17th to 22nd Feb. 2016
GSMaP real-time version (GSMaP_NOW)

- To reduce latency from 4-hr to “quasi-realtime”
  - Using data that is available within 0.5-hour (GMI, AMSR2 direct receiving data, AMSU direct receiving data and Himawari-IR) to produce GSMaP at 0.5-hr before (observation).
  - Applying 0.5-hour forward extrapolation (future direction) by cloud motion vector to produce **GSMaP at current hour (just now)**.

**Description**

**Variable:**
Rainfall rate (mm/hr)

**Domain:**
Geostationary satellite "Himawari" area

**Grid resolution:** 0.1 degree lat/Ion

**Temporal resolution:** 1 hour

**Update interval:** 30 min

**Data latency:** 0-hour after observation

http://sharaku.eorc.jaxa.jp/GSMaP_NOW/
GSMaP NOW Fiji Island Ver.
Fiji customized version is available!!
http://sharaku.eorc.jaxa.jp/GSMaP_NOW/fiji.htm

You can view GSMaP with or without displaying Cloud/rain/microwave radiometer coverage.

If you have any questions or comments, please contact us from here.

Fijian Time

Zoom Up/down

Fiji Islands
Conclusion:

Technology and Our Cooperation change the World better.

Thank you for your kind attention.