Geospatial Infrastructure as a promoter of Innovation on Geospatial Information Technology and Application
- Japan’s examples

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1. What is UN-GGIM-AP?
2. Latest Trends in Surveying and Mapping
3. GSI’s work for Geospatial Society in Japan
   (a) Fundamental Geospatial Data
   (b) Reference of highly precise positioning
4. Various application
5. Summary
1. What is UN-GGIM-AP?

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5. Summary
UN-GGIM-AP: Introduction and Role

UN-GGIM-AP
• Regional Committee of UN-GGIM.
• Established: 1 November 2012
• Member:
  National Geospatial Information Authorities of 56 countries and regions in Asia and the Pacific
• Current Chair: Dr. Hiroshi Murakami (Japan)
• Current Secretariat: China

Vital Role in
(Relevant to geospatial information management)
• Resolves regional issues
• Facilitate regional capacity building
• Promote globally the unique needs and interests of the region
• Contribute to the discussions in UN-GGIM

(Reference)
ECOSOC Resolution entitled “Strengthening institutional arrangements on geospatial information management”, E/RES/2016/27
WG1: Geodetic Reference Framework for Sustainable Development

Chair: Dr. John Dawson (Australia)

- This WG aims to support Asia and Pacific countries to respond to the General Assembly Resolution on a Global Geodetic Reference Frame (GGRF) for Sustainable Development, and to facilitate regional geodetic cooperation.

WG2: Disaster Risk Management

Chair: Mr. Toru Nagayama (Japan)

- This WG aims to enhance the capability of NGIAs in Asia and the Pacific region for contributing to disaster risk reduction by applying geospatial information for effective implementation of Sendai Framework for Disaster Risk Reduction (SFDRR).
WG3: Regional SDI
Chair: Dr. Jiang Jie (China)
• This WG aims to investigate and assess the status of NSDI development of the member countries in the Asia and Pacific region, and to identify common data and service standards for regional sustainable development.

WG4: Cadastre and Land Management
Chair: Dr. Byung-Gul(BG) Lee (Korea)
• This WG aims to promote land administration framework and good practices for the Asia and Pacific region. Main work steps are to identify land issues in the region, propose affordable framework and good practices for the region, and disseminate good practices and enhance training and capacity development..
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5. Summary
We are now witnessing **a Revolutionary Innovation in Surveying and Positioning**, empowered by the combination of Positioning Satellites and CORS networks.

**Multi GNSS**

GNSS: Global Navigation Satellite System(s)

**CORS Network**

CORS: Continuously Operating Reference Station(s)
Applications: Real-time Positioning Services

QZSS (Japan)  GPS (USA)  Galileo (EU)  GLONASS (Russia)

Real-time Positioning Service Provider

CORS Data Center
Surveying and Positioning so far (1)

**Surveying**
- **Purpose:** To know where and what it is.
- **Method:** Triangulation survey, etc.
- **Accuracy:** $\sim 10^{-2}$ meter.
- **Time:** $10^2-3$ days (now $10^1$ days).

It is accurate, but takes some time
Surveying and Positioning so far (2)

Positioning

- **Purpose:** To know where we are now.
- **Method:** Astronomical Survey, Radio navigation, etc.
- **Accuracy:** $\sim 10^2$ meter (now $10^1$ meter).
- **Time:** Near real time.

**It is quick, but not so accurate**

Accuracy

- Higher
- 1 cm
- 10 cm
- meters

Time

- 1 min
- 30 mins

Faster

Navigation

Point Positioning

Global reference
Combination of GNSS and CORS enables Real-time, Accurate Positioning and Surveying.

Innovative Services and New Industry
In February 2015, the UN General Assembly adopted a resolution “A Global Geodetic Reference Frame for Sustainable Development” – the first resolution recognizing the importance of globally-coordinated approach to geodesy.

Many countries realized the importance of their national CORS network since the adoption of the UN resolution.

### Background of the resolution

- Some countries still use local coordinate systems that are not consistent with the global geodetic reference frame.
- GNSS satellites provide coordinates based on a global geodetic reference frame.
- Geospatial information has been and will be increasingly acquired with GNSS.

### Resolution requests the Member States to:

- Improve their global geodetic infrastructures,
- Implement open data sharing, and
- Engage in Education, Training and Capacity Building.
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As a concept of Japan’s basic law and basic plan on NSDI, keyword is "Realization of G-spatial society".

Everyone can use the necessary geospatial information anytime, anywhere, and can obtain accurate information based on sophisticated analysis.

Expected Benefits

- Protect the country, Save each person's life
  - Disaster prevention measures system
- Traffic system & distribution system
  - Logistics network to remote island
- Diverse and rich lifestyles
  - Stress free environment
- Accelerate regional creation
  - i-Construction
  - IT agriculture
GSI’s contribution to G-Spatial Society

- Map infrastructure:
  Fundamental Geospatial Data promotes wider map-application.

- Establishing a National Geodetic Reference Frame:
  Infrastructure of a Society with a Highly Precise Satellite Positioning

  Overlaying with base map

  Promotion of wider application of maps

  Fresh & Accurate

  Data Application by cooperation of various sectors

  Nation-wide CORS network

  Precise reference for elevation developed by accurate gravity data
Fundamental Geospatial Data

• Reference for positioning on digital maps
• Free download available for anyone to use at any time
• Scales are 2,500 (City Planning Area) and 25,000 (Other areas)
• Mostly completed in FY2011

Download basic map information from http://www.gsi.go.jp/kiban/
It took Japan several decades to establish its national geodetic network with triangulation points in the late 19th century.

GNSS CORS networks enable countries to develop a National Geodetic Network and launch real-time positioning services in a few years.

A total of over 110,000 triangulation points were built and surveyed to establish the national geodetic coordinate system.

First-order Triangulation Points Network with Stone Monuments

CORS Network of Japan

GNSS CORS: Crucial Infrastructure in the Era of Satellite Positioning.
• The CORS network has 1318 stations over the whole country (at ~20 km interval).
• The continuous GNSS observation enables accurate measurement of crustal deformation.
GNSS enables us to easily and quickly obtain accurate horizontal positions (longitudes/latitudes), whereas elevations cannot be obtained so accurately yet.

In order to obtain accurate elevations by using GNSS, it is required to measure gravity data densely nationwide to develop an elevation reference.

The elevation reference is developed according to gravitational data. (Leveling is still used in some parts of Japan including certain urban areas.)

More than 1,300 CORSs continuously monitor changes in elevation.

GSI will conduct air-borne gravity survey to grasp area-wide gravity anomaly on the surface.

GSI is realizing a society where anyone can use elevation anytime and anywhere by GNSS.
Realization of a Society Where Highly Precise Positional Information Can Be “Surveyed” Anytime and Anywhere

**GNSS surveying**
Surveyors conduct surveys efficiently in real time.

**Vehicle-mounted laser scanning**
Digitized data for mapping are obtained efficiently by running a vehicle equipped with a laser scanner to measure ground surfaces.

**Promotion of I-Construction**
The application of location information including the automation of construction machinery improves productivity in the field of construction.

**Autonomous driving of farming machinery**
Precise positioning enables the autonomous driving of farming machinery and improves the efficiency of farm work in response to a shortage of labor.

Credit: Brochure of the Geospatial Project, Secretariat of the National Spatial Data Infrastructure (NSDI) Committee
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Disaster Cycle and Geospatial Information

Surveying technique and geospatial information are precious technology and information that can contribute to disaster risk reduction and reconstruction.
Aerial Photos

The 2016 Kumamoto Earthquake (M7.3) GNSS CORS provides accurate positional control to the airplane.

- Aerial photos were taken in cooperation with private companies.
- The photos revealed the impact and extent of damage caused by the earthquake in detail.
Drones (UAV: Unmanned Aerial Vehicle)

The 2016 Kumamoto Earthquake (M7.3)

- Drones allow a closer look at and acquire the images of inaccessible damaged areas (landslide sites, etc.).
Air Photos on Web Maps
Due to the deformation caused by the Great East Japan Earthquake, the control point coordinates had to be transformed to new ones for reconstruction.
Hazard Maps prepared by Local Municipalities

- **Ota-Ku, Tokyo**
  - Flood Hazard Map
  - Height Tide Hazard Map
  - Volcano Hazard Map
- **Minato-Ku, Tokyo**
  - Inland Waters Hazard Map
  - Map of the supposed inundation area
  - Earthquake Damage Estimation Map
- **Utsunomiya City, Tochigi Prefecture**
  - Landslide Disaster Hazard Map
  - Tsunami Hazard Map
  - Ground Subsidence(Liquefaction) Map
- **Shimonoseki City, Yamaguchi Prefecture**
  - Height Tide Hazard Map
- **Kochi City, Kochi Prefecture**
  - Volcano Hazard Map
  - Ground Subsidence(Liquefaction) Map
- **Mishima City, Shizuoka Prefecture**
  - Earthquake Damage Estimation Map
- **Nishio City, Aichi Prefecture**
  - Tsunami Hazard Map
Hazard Map Portal

Information useful for evacuation and disaster preparedness is released

Heavy rain
- areas vulnerable to flooding
- landslide-prone areas
- roads that are likely to get blocked

Earthquake
- areas prone to shaking
- locations of active faults
- massive developed land

Overlaid hazard maps
Various information about anywhere in Japan, which is useful for disaster risk reduction, can be overlaid and viewed as a single map.

Local hazard maps
Hazard maps of municipalities across Japan are available.

Understanding various information is useful for evacuation planning and disaster preparedness

Evacuation route
Measures for flooding
Enhancing seismic safety
Measures for liquefaction

Hazard Map Portal Site: http://disaportal.gsi.go.jp/
(run by Ministry of Land, Infrastructure, Transport and Tourism of Japan)
Providing Information through GSI Website

GSI Maps 3D (4/17~)

3D models created with GSI Maps 3D

GSI Maps Globe (experimental release) (4/21~)
Activities during the pre-disaster period

(Examples)

1. Outputs by the Headquarters for Earthquake Research Promotion

2. Recent activities by the Japan Meteorological Agency (JMA)

3. Hazard map Portal by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
The Headquarters for Earthquake Research Promotion (HQERP) is the Government Organization under the Ministry of Education, Culture, Sports, Science and Technology, established in 1995.

- Probability of suffering a ground motion with very strong seismic intensity within 30 years hereafter (as of 2018)
- An example of Probabilistic Seismic Hazard Maps
- Source: National Seismic Hazard Maps for Japan 2018, HQERP (only in Japanese)
J-SHIS was established to help prevent and prepare for earthquake disaster by providing a public portal for seismic hazard information across Japan.

Probability of Exceedance [seismic intensity 6] in 30 years

Scenario Earthquake Shaking Maps

Affected Population

Simulation result in seismic intensity
Recent Activities by Japan Meteorological Agency

Examples of municipal and resident responses to weather Warnings/Advisories

<table>
<thead>
<tr>
<th>Weather Warning/Advisory type</th>
<th>Municipal responses</th>
<th>Resident responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emergency Warning</strong> (Significant likelihood of catastrophe)</td>
<td>Sediment incident</td>
<td>Heavy rain Emergency Warning (sediment incident)</td>
</tr>
<tr>
<td>Sediment Incident Alert</td>
<td>Inundation</td>
<td>Heavy rain Emergency Warning (inundation)</td>
</tr>
<tr>
<td>Storm</td>
<td>Storm Emergency Warning</td>
<td>Storm surge</td>
</tr>
<tr>
<td>High waves</td>
<td>High wave Emergency Warning</td>
<td>Heavy snow</td>
</tr>
<tr>
<td>Snowstorm</td>
<td>Snowstorm Emergency Warning</td>
<td></td>
</tr>
</tbody>
</table>

**Municipal responses**
- Immediately urge residents to take all possible steps for self-protection
- Alert residents to the issuance of an Emergency Warning and highlight the exceptionally dangerous situation

**Resident responses**
- Take immediate action for self-protection (head to an evacuation center, or if it is dangerous to go outside, evacuate to a safer place within the building)
- Start voluntary and early evacuation or follow evacuation advisories/orders
- For Storm Warnings, evacuate to a safe place
- Report abnormalities to municipalities and other authorities
- Stay away from hazardous places
- Prepare for evacuation
- Check emergency supplies
- Check evacuation routes and centers
- Check windows and storm shutters
- Monitor weather bulletins on TV, radio and JMA’s website

- **3 stages of weather warnings / advisories by JMA**
Recent Activities by JMA

- JMA started to release their forecast of the transition of the weather since July 2017, when a state of critical urgency is coming with approaching big storm, torrential rains, and so on.

**Example 1**

Released on 11:00, 28 August by Morioka Local Meteorological Observatory

- There is some possibility of issuing a warning of heavy rain in the northern coastal region within 30 hours.

<table>
<thead>
<tr>
<th></th>
<th>28 Aug.</th>
<th>29 Aug.</th>
<th>30 Aug.</th>
<th>31 Aug.</th>
<th>1 Sep.</th>
<th>2 Sep.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>until dusk</td>
<td>night time</td>
<td>from morning till midnight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy Rain</td>
<td>12-18</td>
<td>18-6</td>
<td>6-24</td>
<td>High</td>
<td>High</td>
<td>-</td>
</tr>
<tr>
<td>Storm</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>High</td>
<td>High</td>
<td>-</td>
</tr>
<tr>
<td>Waves (High Sea)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>High</td>
<td>High</td>
<td>-</td>
</tr>
</tbody>
</table>
Recent Activities by JMA

- JMA started to release their forecast of the transition of the weather since July 2017, when a state of critical urgency is coming with approaching big storm, torrential rains, and so on.

**Example 2**

- Delivering information about forecasting of the transition of the weather at every local government by each Local Meteorological Observatory.

<table>
<thead>
<tr>
<th>Town Name</th>
<th>Red: Warning, Yellow: Advisory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk of Inundation</td>
<td></td>
</tr>
<tr>
<td>Risk of Landslide</td>
<td></td>
</tr>
<tr>
<td>Risk of Strong Wind</td>
<td></td>
</tr>
<tr>
<td>Risk of Big Wave</td>
<td></td>
</tr>
<tr>
<td>Risk of High Sea</td>
<td></td>
</tr>
<tr>
<td>Risk of Fog</td>
<td></td>
</tr>
</tbody>
</table>

Weather phenomena, such as heavy rain, storm, thunder, fog, and so on.
Recent Activities by JMA

• JMA started to open river data about real-time forecast of flux over 20,000 rivers in Japan since July 2017.
The MLIT is running a website named Hazard Map Portal since 2007. Estimated flood area, road information, risk area can be shown with maps and aerial photos.

This example shows distribution of potential areas suffering from landslide, debris flow and slope collapse.

Base map data and the platform for web map are offered by GSI.

Ministry of Land, Infrastructure, Transport and Tourism of Japan
<table>
<thead>
<tr>
<th>管轄地方整備局</th>
<th>水系名</th>
</tr>
</thead>
<tbody>
<tr>
<td>北海道開発局</td>
<td>石狩川 屋別川 後志利別川 髙川 沙流川 大津川 香</td>
</tr>
<tr>
<td>東北地方整備局</td>
<td>阿武隈川 名取川 鳴瀬川 北上川 黒川 高瀬川 岩</td>
</tr>
<tr>
<td>関東地方整備局</td>
<td>河川 那珂川 久慈川 見川 多摩川 相模川</td>
</tr>
<tr>
<td>北陸地方整備局</td>
<td>荒川 阿賀野川 信濃川 関川 刚川 黒川 常磐寺川</td>
</tr>
<tr>
<td>中部地方整備局</td>
<td>鴨川 安曇川 太井川 天竜川 葛川 豊川 矢作川</td>
</tr>
<tr>
<td>近畿地方整備局</td>
<td>新宮川 紺の川 大和川 濃川 加古川 播磨川 円山川</td>
</tr>
<tr>
<td>中国地方整備局</td>
<td>千代川 天神川 日野川 窪伊川 高津川 江の川 吉井</td>
</tr>
<tr>
<td>四国地方整備局</td>
<td>吉野川 郎原川 物部川 仁淀川 濃川 革川 重信川</td>
</tr>
<tr>
<td>九州地方整備局</td>
<td>潮川 川内川 大分川 大野川 番匠川 五ヶ瀬川 小</td>
</tr>
</tbody>
</table>

Hazard Map Portal by MLIT

Predicted Inundated Area
DiMAPS (Integrated Disaster Information Mapping System)

DiMAPS by MLIT.
Disaster information and relevant information is displayed on the web map.

This example shows distribution of potential areas suffering from river flood.

Base map data and the platform for web map are offered by GSI.

Locations of MLIT Branches, Evacuation Area, Local Government, etc.
Geospatial Information Platform for Decision Makers

On-site vehicles

Water gauge

Date/Time

Water Level

16.0
12.0
8.0
4.0
0.0
-4.0

18:00  24:00  06:00  12:00  18:00  24:00  06:00  12:00

3/8  3/9  3/10
Video images taken from a helicopter and ortho-rectified near real-time
Activities during the pre-disaster period

• These examples showed above are open to the public each by each, as a judgement of the Japanese Government.

• The indicators for disaster risks may have spatial distribution.
  e.g. Probability of the big earthquake, land slides, etc.

• Geospatial tools may help visualizing these risks so that people can understands these risks properly to reduce the loss by disaster.

• Some data are offered to the running organizations from the GSI. The GSI continues to cooperate with those organizations.
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SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

SDG 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development
Summary

• We are now witnessing a Revolutionary Innovation in geospatial information technologies.

• National Geospatial Information Authorities in Asia and the Pacific annually have UN-GGIM-AP meeting to discuss technical and substantive activities in the geospatial information field at the regional level.

• Japan has national vision of “G-spatial Society” and relevant ministries and stakeholders collaboratively make efforts, and GSI contributes to provide geospatial infrastructure.

• Such geospatial infrastructure will contribute to achieve SDGs.
Thank you!