# Satellite Derived Bathymetry (SDB) Summary of FY2014 – 2016 study in Japan

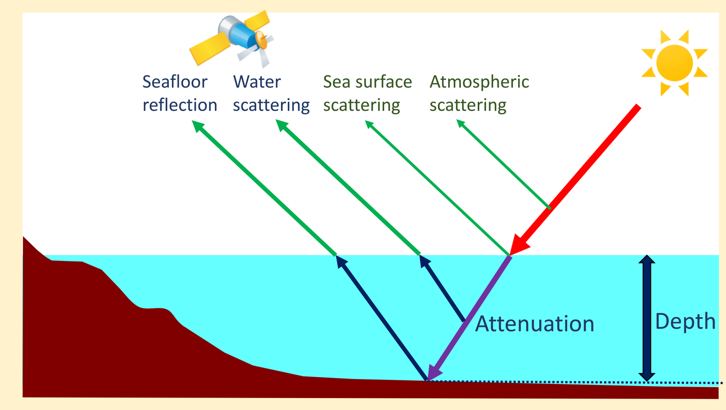
Hydrographic and Oceanographic Department, Japan Coast Guard (JHOD) conducted a joint study project on Satellite Derived Bathymetry (SDB) with Remote Sensing Technology Center of Japan (RESTEC) and Japan Hydrographic Association (JHA) during FY2014-2016, financially supported by the Nippon Foundation. The objective of this joint study is to evaluate the performance of SDB in Japanese waters, mainly located in the Temperate Zone. This poster introduces the major results of the SDB study and the outline of the developed SDB analysis tool.

## 1. Background

- SDB is a rapid and low-cost tool to cover unsurveyed or poorly surveyed areas and expected to utilize for
  - monitoring changes of water depths at shallow waters
  - reconnaissance survey for shallow waters
  - disaster recovery planning of harbours
- The International Hydrographic Organization (IHO) has enhanced SDB in recent years.
- France has published a part of their nautical charts using SDB for over 20 years. UK also published a nautical chart including SDB in 2015.
- Japan tried to assess the potential availability of SDB through study during 2014-2016.

## 2. SDB

- Radiance measurement by satellite multispectral imagery
- Water depth can be derived from the attenuation of light
- Small amount of training data (sounding depths) required

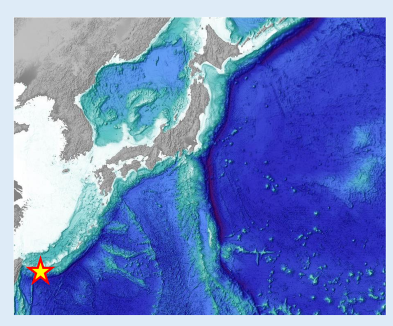



## 3. Major conditions of this study

- Various trial SDBs created from archived images of WorldView-2 satellite
- Water and seabed conditions in the Temperate - Subtropical regions
- Empirical estimation method using small amount of training data (sounding depths)

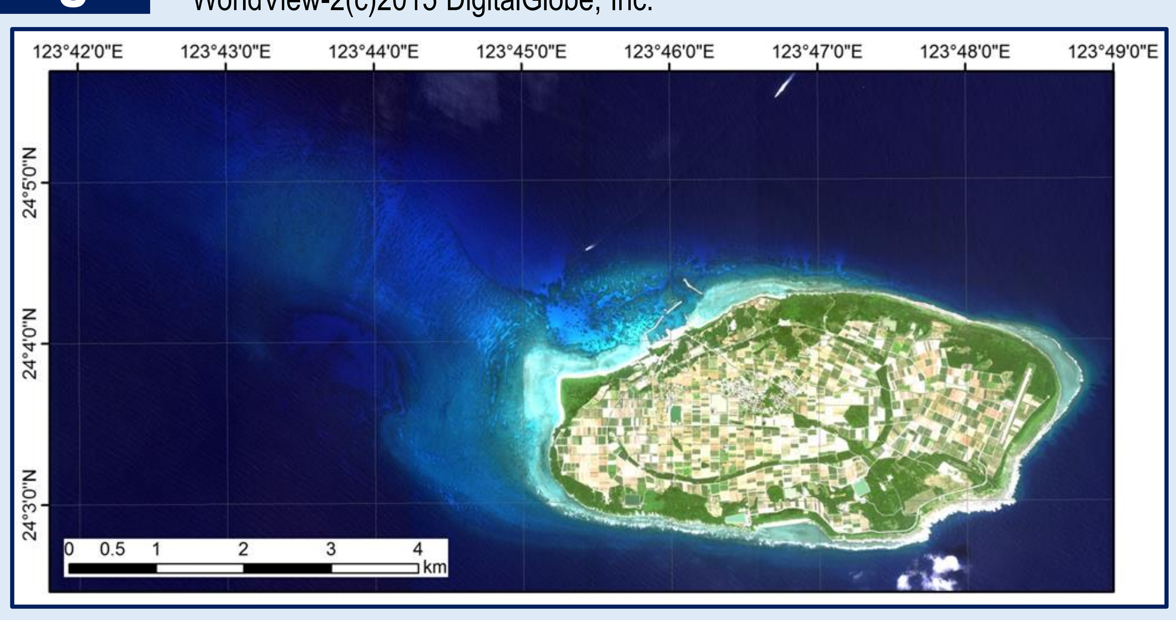
## 4. Results of trials in 3 areas

### 4.1 Hateruma Is., Okinawa pref.



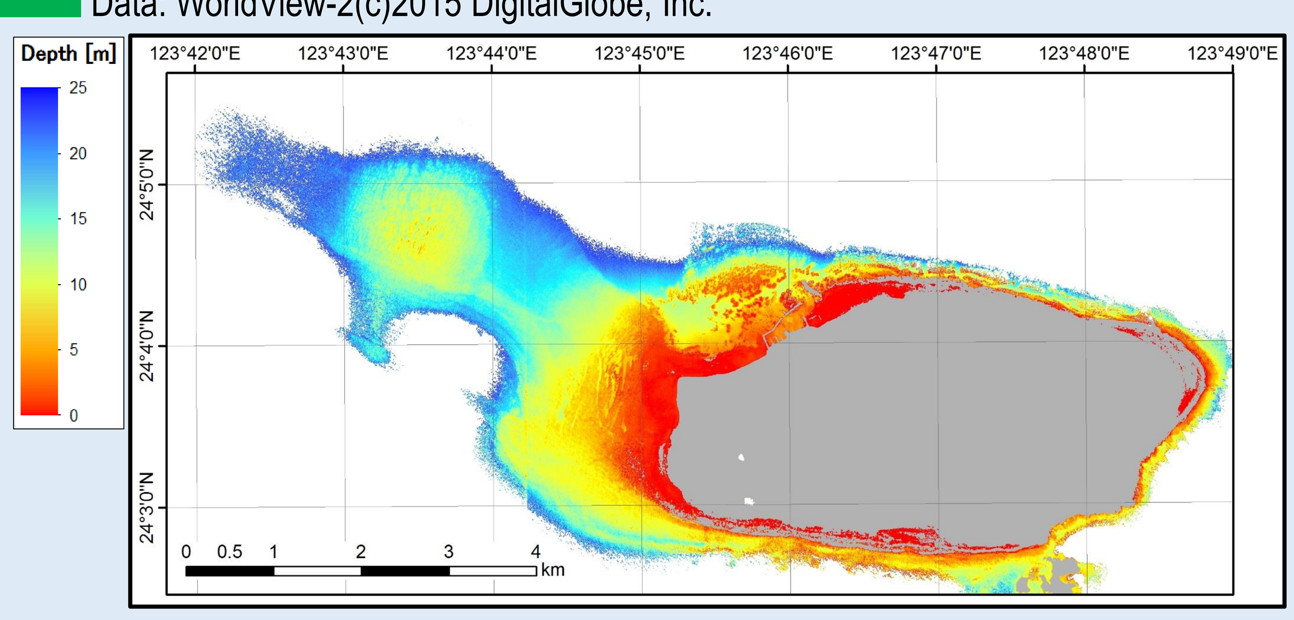
WV2 Image

18 May 2013; 75km²
WorldView-2(c)2015 DigitalGlobe, Inc.



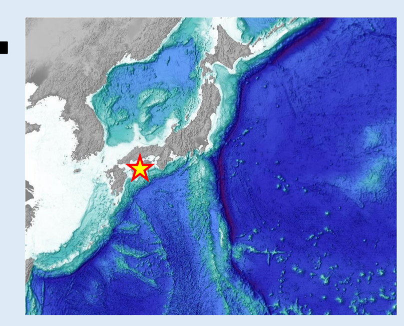
SDB

Analyzed by (c)RESTEC
Data: WorldView-2(c)2015 DigitalGlobe, Inc.



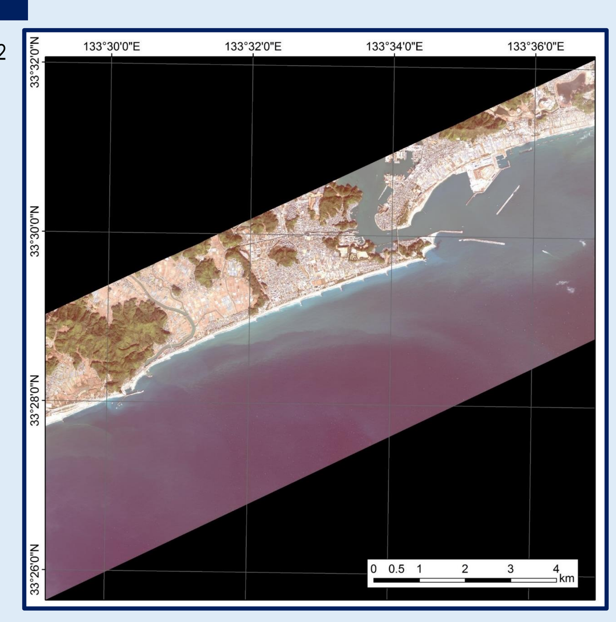

- Excellent water clarity. Penetrates down to 24 m deep.
- Depth uncertainty was 2-6 m, degraded along with depth.
- Seabed was mostly sandy, but some coral clusters.

### 4.2 Off Kochi pref.



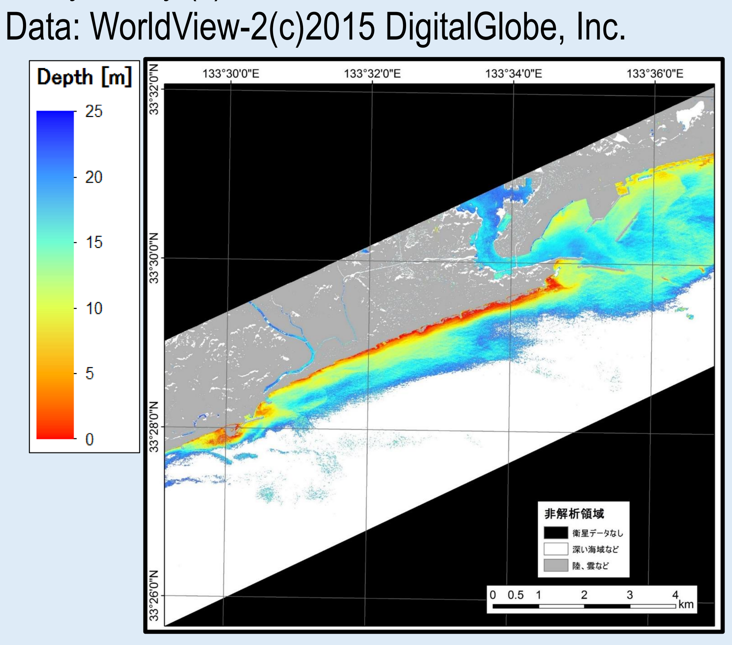
WV2 Image

31 December 2012; 75km²
WorldView-2(c)2015
DigitalGlobe, Inc.



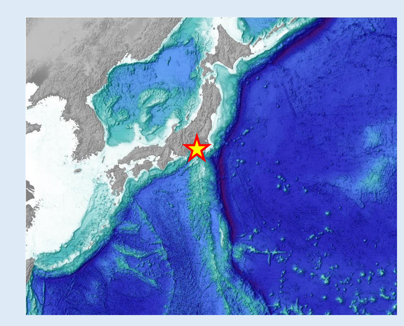
SDB

Analyzed by (c)RESTEC
Data: WorldView-2(c)2015 DigitalGlobe, Inc.



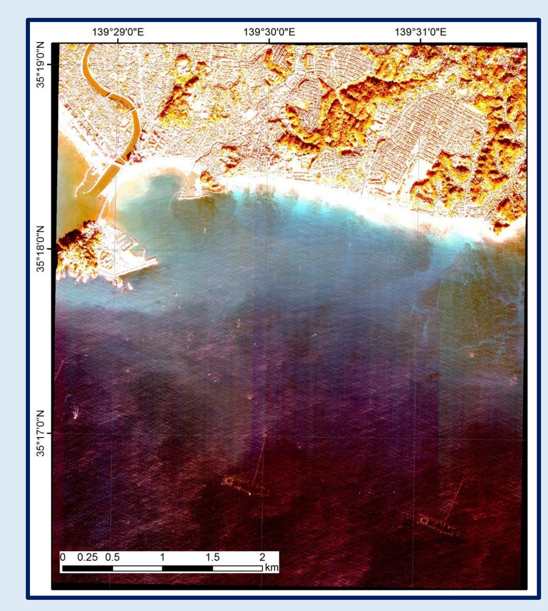

- Penetrates down to 20 m deep.
- Depth uncertainty was 2-5 m.
- Variety of water clarity and seabed.

### 4.3 Off Kamakura



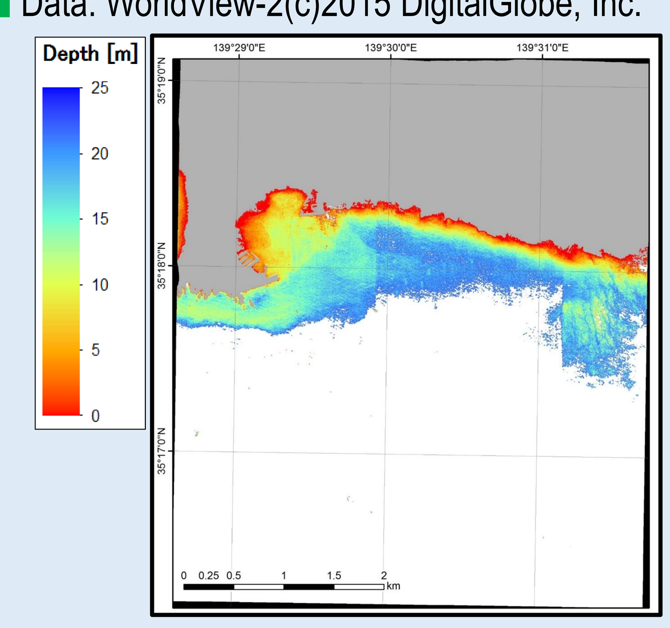
WV2 Image

28 December 2013;
25km²
WorldView-2(c)2015
DigitalGlobe, Inc.



SDB

Analyzed by (c)RESTEC
Data: WorldView-2(c)2015 DigitalGlobe, Inc.




- Penetrates down to 9 m deep.
- Depth uncertainty was 1-2 m.
- Seabed was muddy, but some rocks.

## 5. Summary of study

### 5.1 Performance of SDB in this study

**Resolvable maximum depth**

- Penetrates down to approx. 24 m deep in the best condition, such as Hateruma Is..
- At most areas around mainland Japan, penetration was down to approx. 10 m deep.

**Accuracy**

- The average of error was approx. ±2.6 m (95%CL) / ±1.3 m (RMSE) in the best condition, such as Hateruma Is..
- Sometimes the error worsened up to approx. ±5 m (95%CL). The average of error often fluctuated with depth.

**Influence of the distribution of training data (*in situ* soundings)**

- Properly estimated, if training data are randomly distributed, training data should well represent the variety of depth, the nature of seabed, and water clarity in the given area.
- Topography did not affect the accuracy.
- 200 points of training data would be enough for estimation.

### 5.2 Comparison of performance at Hateruma Is., by several optical sensors

| Satellite | Pixel size | number of bands | $R^2$ | 95%CL (m) | RMS Error (m) |
|---|---|---|---|---|---|
| WorldView-2<br>Many bands, high resolution | 2 m | 8<br>(6 visible) | 0.959 | ±2.58 | 1.31 |
| GeoEye-1 | 2 m | 4<br>(3 visible) | 0.916 | ±3.62 | 1.85 |
| SPOT6 | 6 m | 4<br>(3 visible) | 0.998 | ±1.96 | 1.00 |
| Landsat-8<br>Free of charge! | 30 m | 8<br>(4 visible) | 0.942 | ±3.04 | 1.55 |

- Pixel size would not affect estimation accuracy.
- Images of lower resolution are also applicable.

## 6. Developed SDB software

- As a result of this study, we developed and improved analysis method for SDB based on relevant existing studies, and produced an SDB analysis tool "BathymetryMapper 2.0".
- Free GIS software QGIS is also used in the SDB analysis flow.
- The SDB analysis tool is licenced and provided by JHA.