

Study on Commercial Satellite Imagery for Safeguards

150

IAEA(International Atomic Energy Agency) 가

1m 가

IAEA

Abstract

Under the strengthened safeguards system, the IAEA applies all available information technology and open source information to verify the correctness and completeness of the declaration of the Member States and monitor whether there are undeclared nuclear activities. Rapidly available commercial satellite imagery which covers wide area is now considered as very useful open source information. Nowadays panchromatic commercial satellite imagery has 1m spatial resolution and can be applied in the field of safeguards. This paper treats the basis of the IAEA's application of satellite imagery taken on the Member States, status of satellite imagery, potential application of satellite imagery in international safeguards and our preparation to this trend.

1.

(IAEA, International Atomic Energy Agency) (Safeguards System) 30 . 1997

5 IAEA 'Model Protocol Additional to Safeguards Agreements' (' 가) 1999 6 가

2001 가 (spatial information) 가

가

가

[3]. IAEA 가 . IAEA

가 [3].

- (Use of Imagery as Reference Information)
- IAEA (Confirmation of Agency Information)
- (Change Detection and Monitoring)
- 가 (Assessing Open Sources Information)
- (Detecting Undeclared Activities)

[2].

- 가
- (site information database)

- 가

4.

(KARI: Korea Aerospace Research Institute) 1999 12 21
 1 (KOMPSAT-1: Korea Multi-Purpose Satellite-1, ' 1 ')
 1 (EOC: Electro Optical Camera)
 (1).

1. (EOC)
 (: [4] 4 2)

	6.6 m ± 10% (GSD: Ground Sample Distance)
	510 ~ 730 nm (panchromatic)
	1.42° (FOV: Field Of View)
F number	8.3
	1.046 m
MTF	>10% (), >8% ()
SNR	50
/ /pixel	CCD / push-bloom / 2592 pixels
	>0.9
(swath)	15 km
Duty cycle	2 (800 km)
	X-band
	< 25Mbps
	28 39 가 20 가
	± 30° rolling
	(Ground Control Point)
	60 kg, 50 W

EOC (DEM: Digital Elevation Model) . EOC 가 510 ~ 730 nm
 (全整色, panchromatic)

(stereo image) . 685km . EOC
2 .

2. EOC 가
(: [4] 4 1)

	- - -
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가

IAEA
[2~3].

가 2000 1m 가
가 [5~9].

5. GIS(Geographic Information System)

1990

가

1990

GIS

[10].

가

(NSDI: National Spatial Data Infrastructure)

가

[11].

가 GIS (NGIS: National Geographic Information Systems)

[12].

(RS: Remote Sensing)

(sensor)

가

(分光學)

(Satellite Remote Sensing)

1972

ERTS-1(Earth Resources Technology Satellite,

Landsat-1

)

(空間解像度, spatial resolution; 가

) (分光解像度, spectral resolution;

가)

NASA, CNES

가

가

1992

가

가 'Open Skies'

가

[11].

가.

1km

가

30

km

NOAA (National Oceanic and Atmospheric Administration)

(Multi-Spectral)

(spectral band)

Landsat MSS

(Multi-Spectral Sensor), TM (Thematic Mapper),

IKONOS,

SPOT

(Systeme Pour l'Observation de la Terre) HRV (High Resolution Visible)

Landsat

IKONOS

3

3. Landsat, IKONOS

	Landsat TM (: 30 m)	Landsat MSS (: 80 m)	IKONOS (: 4 m)
	1 : 0.45~0.52 μm	-	1 : 0.45~0.53 μm
	2 : 0.52~0.60 μm	4 : 0.50~0.60 μm	2 : 0.52~0.61 μm
	3 : 0.63~0.69 μm	5 : 0.60~0.70 μm	3 : 0.64~0.72 μm
	4 : 0.76~0.90 μm	6 : 0.70~0.80 μm	4 : 0.77~0.88 μm
	5 : 1.55~1.75 μm	7 : 0.80~1.10 μm	-
	6* : 2.08~2.38 μm	-	-
	7 : 10.4~12.5 μm	-	-

* TM

6

120m x 120m

(panchromatic stereo)

3

(DEM, Digital Elevation Model)

(Digital Ortho Image)

SPOT HRV P

Open Skies

가

4

Space Imaging 가

e-

HD.com

(1m)

5

4. IKONOS

(: e-HD.com)

	(CE*)	(RMSE**)	
Geo	50 m CE 90%	23.6 m RMSE	1:100,000
Reference	25 m CE 90%	11.8 m RMSE	1:50,000
Map	12 m CE 90%	5.7 m RMSE	1:25,000
Pro	10 m CE 90%	4.8 m RMSE	1:12,000
Precision	4 m CE 90%	1.9 m RMSE	1:4,800
Precision Plus	2 m CE 90%	0.9 m RMSE	1:2,400

* CE: Circular Error, ** RMSE: Root Mean Square Error

5. National Map Accuracy Standards (NMAS, U.S.A.)

(: [13] Figure 3)

Map scale examples	NMAS (horizontal accuracy)	Typical Features
Large scale 1:2,400 1:12,000	No more than 10% of features shall be more than 1/30 th of an inch from their intended location on maps of scale of 1:20,000 or less	Trees, canals, transmission towers, residences, tanks, towers, fences, walls
Small scale 1:500,000 1:1,000,000	No more than 10% of features shall be more than 1/50 th of an inch from their intended location on maps of scale greater than 1:20,000	Metropolitan areas, major airports, large rivers, large industrial buildings

Landsat, SPOT, NOAA

0.3 ~ 14 μm

가

1 mm ~ 1 m

(Hyper-spectral)

0.02 ~ 0.04 μm

. GIS , GIS 가

Agency) NIMA (National Imagery and Mapping Agency)
NRO (National Reconnaissance Office)

Commercial Imagery Strategy (CIS)

[14]. 1

NIMA

DTED Level 0 (<http://164.214.2.59/geospatial/products/DTED/dted.html>)

1

[15]. 2

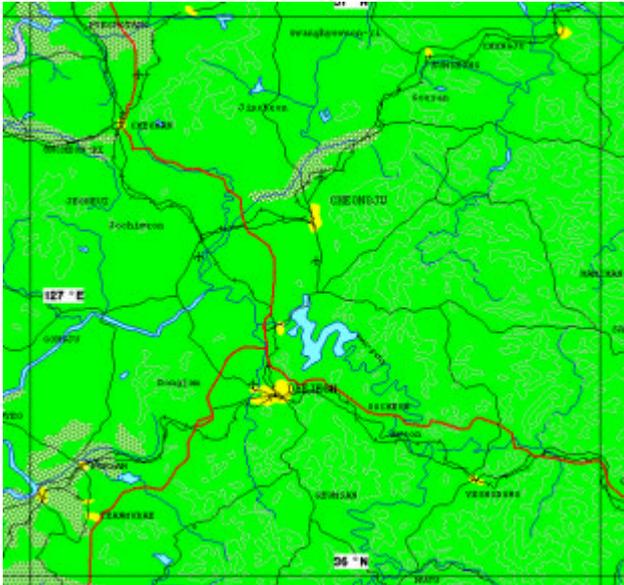
1 가 2000

3 9

(Korea Atomic Energy Research Institute)

JPEG

2



1. (: DTED Level 0 of NIMA,)

2. (1 2000 3 9 ,)

6.

1999 6 가 . 2001 가
가 가
. IAEA 가
. (GIS) 가 IAEA
가 (NGIS)
IAEA

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