

Technical Seminar for Diplomats  
*Vienna, 3-5 February 2009*

# Satellite Imagery as Verification Tool for Safeguards

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**IAEA**

International Atomic Energy Agency

## The Satellite Imagery Analysis Unit (SIAU)

- Provide analytical services related to the exploitation of satellite imagery in support of inspection and verification activities
- Collect, process, analyze, and disseminate imagery-derived products to Safeguards
- Provide geospatial information - identifying the "what" and "where" of a feature or object on the Earth's surface



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## Role of Satellite Imagery Analysis

- Monitor Nuclear Sites & Activities  
(baseline, updates, change detection)
- Verify Additional Protocol (AP) Declarations
- Verify Design Information (DIV)
- Support/Drive Complementary Access (CA)
- Investigate Alleged Undeclared Activities  
(based on Open Source & Third Party information )



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## Satellite Imagery: Change Detection

Natanz Uranium  
Enrichment  
Plant

20 SEP 2002



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## Satellite Imagery: Change Detection

Natanz Uranium Enrichment Plant

29 FEB 2004



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## Satellite Imagery: Change Detection



Image: DigitalGlobe/ISIS

Lavizan-Shian Site, Iran -- August 11, 2003



IRAN: Lavizan Site

Published by ISIS on 18 June 2004

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## Satellite Imagery: Change Detection



Image: DigitalGlobe/ISIS

Lavizan-Shian, Iran -- March 22, 2004



IRAN: Lavizan Site

Published by ISIS on 18 June 2004

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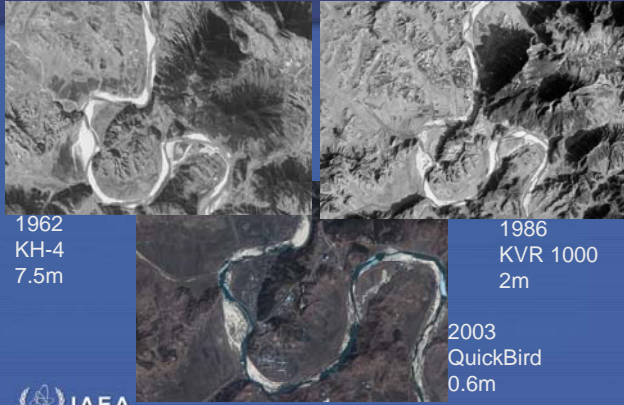
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### Satellite Imagery: Historical Information



1962  
KH-4  
7.5m

1986  
KVR 1000  
2m

2003  
QuickBird  
0.6m



Contains DigitalGlobe, Sovinformsputnik and USGS copyrighted materials

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### Satellite Imagery: Additional Protocol Verification

Satellite imagery provides a description of features by their size, shape, location and any deviations from the State's declaration. It also aids in the identification of locations for CA.



Contains DigitalGlobe copyrighted materials

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### An Example of Different Imaging Sensors

*Nyongbyon as an example*

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Formosat (Taiwan, China)  
2m



WorldView-1 (US)  
0.5m

The SIAU is using high-resolution imagery from 2.5m to the best commercially available sensor 0.5m

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## An Example of Different Imaging Sensors Mine Example

Spot-5  
2.5m



Contains Spot Image copyrighted materials

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## Satellite Imagery: A Radar Example

### SAR Provides Complementary & Additional Info

- Cloud Penetration
- All-Weather
- Day/Night
- Sensitivity to Metal Objects



Contains Infoterra copyrighted materials

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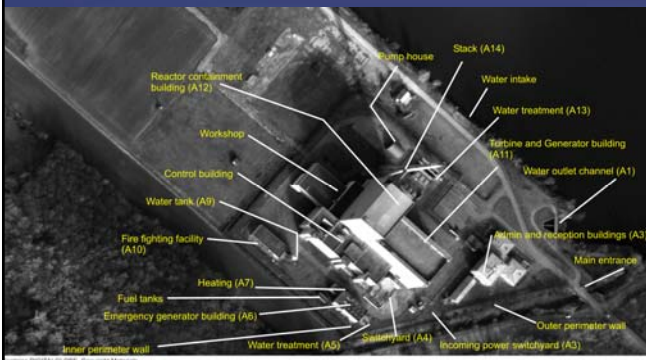
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## Satellite Imagery: The Optical Counterpart



Natural Color, High Interpretability, Clear/Direct Representation




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# Imagery Analysis

*VIDEO*  
The Satellite Imagery  
Analysis Unit  
Supporting IAEA  
Verification Activities



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# Geographic Information System

A GIS links various information & data types spatially to one single information system

Satellite Images



Open Source



Vector Data



Cartographic Maps



3D Information



Image Products



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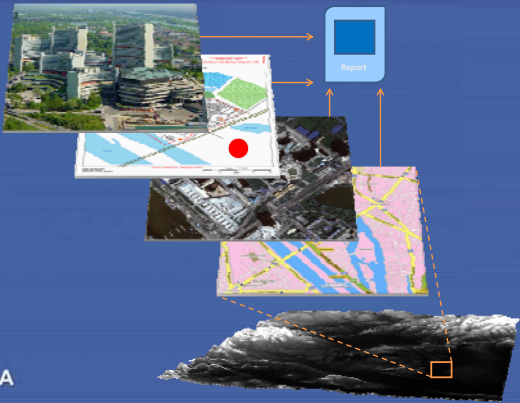
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# Geographic Information System



1:5000



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**Improving the Efficiency  
& Effectiveness of Satellite Imagery**  
GeoEye-1, 0.5m resolution, 2009-01-20



Contains GeoEye copyrighted materials



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**Member State Support Programme**

MSSP R&D is essential in maintaining and growing a strong analytical capability

- HW/SW
- R&D for enhancing analytical methods
- Training
- Expertise



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**Diversification of Sources**

- Enhances our ability to assess the extent and status of nuclear activities of States
- Ensures the integrity and authenticity of satellite imagery



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## Diversification of Sources

### Available high-resolution commercial sensors

- Spot 5, 2.5m (France)
- Formosat-2, 2m (Taiwan, China)
- KVR-1000, 2m (Russia)
- TerraSAR-X, 1m SAR (Germany)
- Cosmo-Skymed, 1m SAR (Italy)
- Kompsat-2, 1m (Korea)
- DK-1, 1m (Russia)
- Ikonos-2, 1m (USA)
- Eros B, 0.7m (Israel)
- QuickBird, 0.6m (USA)
- WorldView-1, 0.5m (USA)



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## Diversification of Sources

### Future high-resolution commercial sensors

- 2009: GeoEye-1, 0.5m resolution (USA)  
WorldView-2, 0.5m resolution (USA)
- 2010: Pléiades, 0.7m resolution (France)
- 2012: Göktürk, 0.7m resolution (Turkey)
- ...Cartosat-2, <1m resolution (India)



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## Conclusions

- Commercial satellite imagery is an integral part of Safeguards – operationally and routinely used
- Imagery analysis has proven to be a powerful safeguards tool:
  - Supporting inspection & verification of declared activities
  - Identifying, characterizing & monitoring undeclared sites
- SIAU analysts have unique knowledge/expertise in imagery-based NFC signatures and observables
- Commercial satellite imagery is expected to play an increasing role in verification (20/20)



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