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# **Interoperability and Deep Learning for Smart City Implementation and Disaster Monitoring Application**

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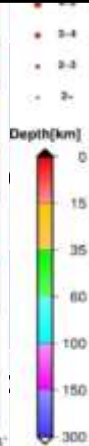
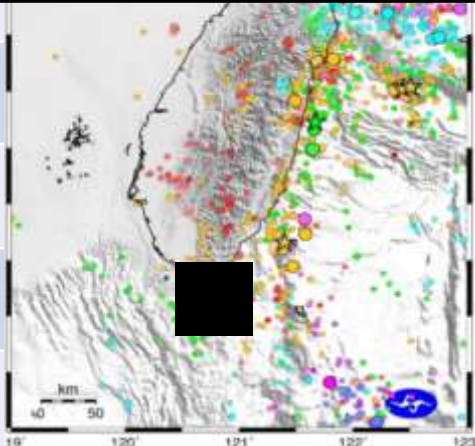
Director/Distinguished Professor, GIS Research Center, Feng Chia University, Taiwan  
Chair, Open Geospatial Consortium (OGC) Asia Forum



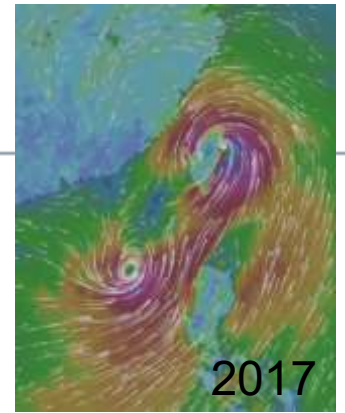
# 44,000 earthquakes a year in average more than 900 > M 4.0



	2010	2011	2012	2013	2014	2015	2016	2017	Location	Magnitude
7≤M	0	0	0	0	0	0	0	0		
6≤M<7	2	0	3	4	1	4	4	1		
5≤M<6	32	15	21	19	22	26	27	15		1 to 2
4≤M<5	133	147	151	152	138	208	172	108		2 to 3
3≤M<4	1,253	1,347	1,106	1,183	1,068	1,386	1,381	903		
2≤M<3	8,814	8,505	7,115	8,458	7,478	9,670	8,778	6,157	heavy traffic	3 to 4
1≤M<2	12,496	11,333	18,782	27,590	21,309	26,094	28,863	15,351		
0≤M<1	543	448	4,195	8,104	6,747	7,448	10,192	5,346	free standing objects	4
Total	23,273	21,795	31,373	45,510	36,763	44,836	49,417	27,881		4 to 5
Felt Events	754	776	1,012	1,272	975	908	1,573	154	falling objects	5 to 6
Felt Reports	153	172	214	166	154	100	112	60		6
									to building	6 to 7
									es begin to collapse, pipes break	7
									ed, many buildings destroyed. Some	7 to 8
									in standing, bridges destroyed.	8
									objects thrown in air, shaking and distortion of	8 or greater

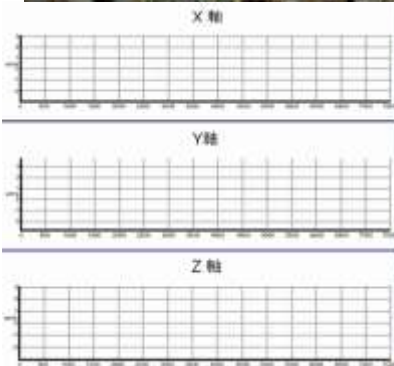
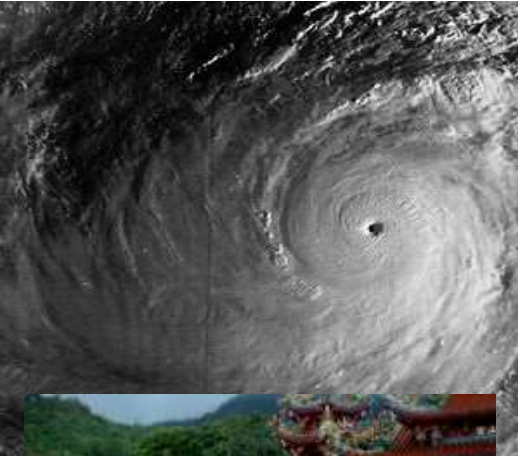


# Typhoon



Typhoon invaded Taiwan in these 2 decades

hit by Typhoon Soudelor





2016



2015



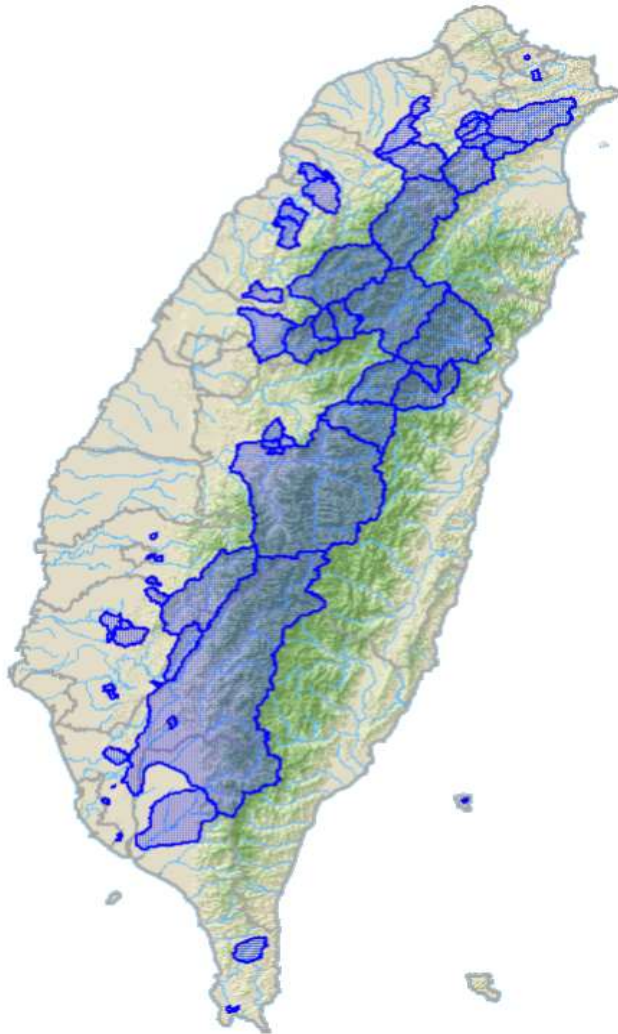
2017 6.2



2017

蘋果日報

# *What we've concerned*

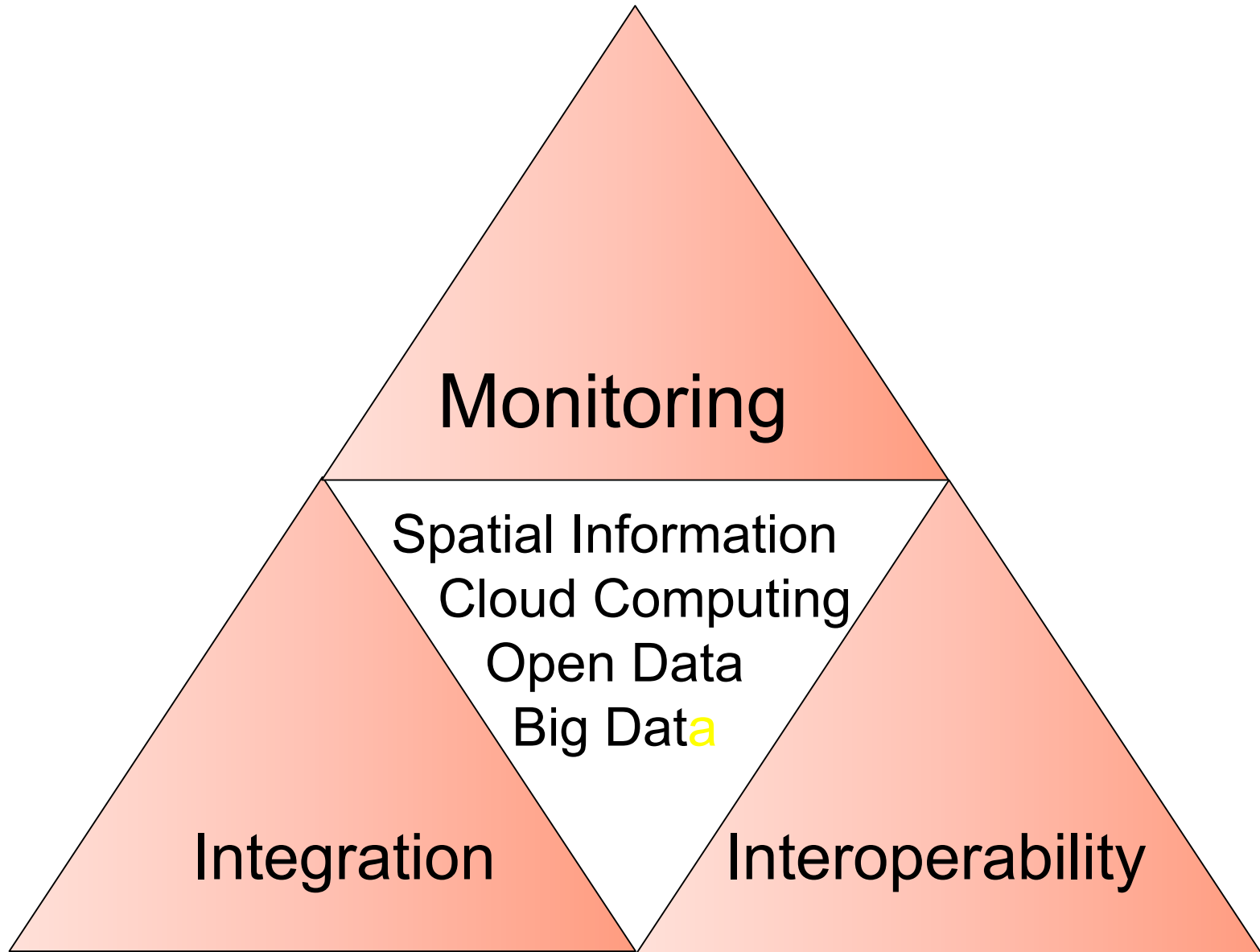


## Environmental monitoring

- Most area in Taiwan is fragile and sensitive.
- Various equipment used to detect and monitor all kinds of environmental characteristics

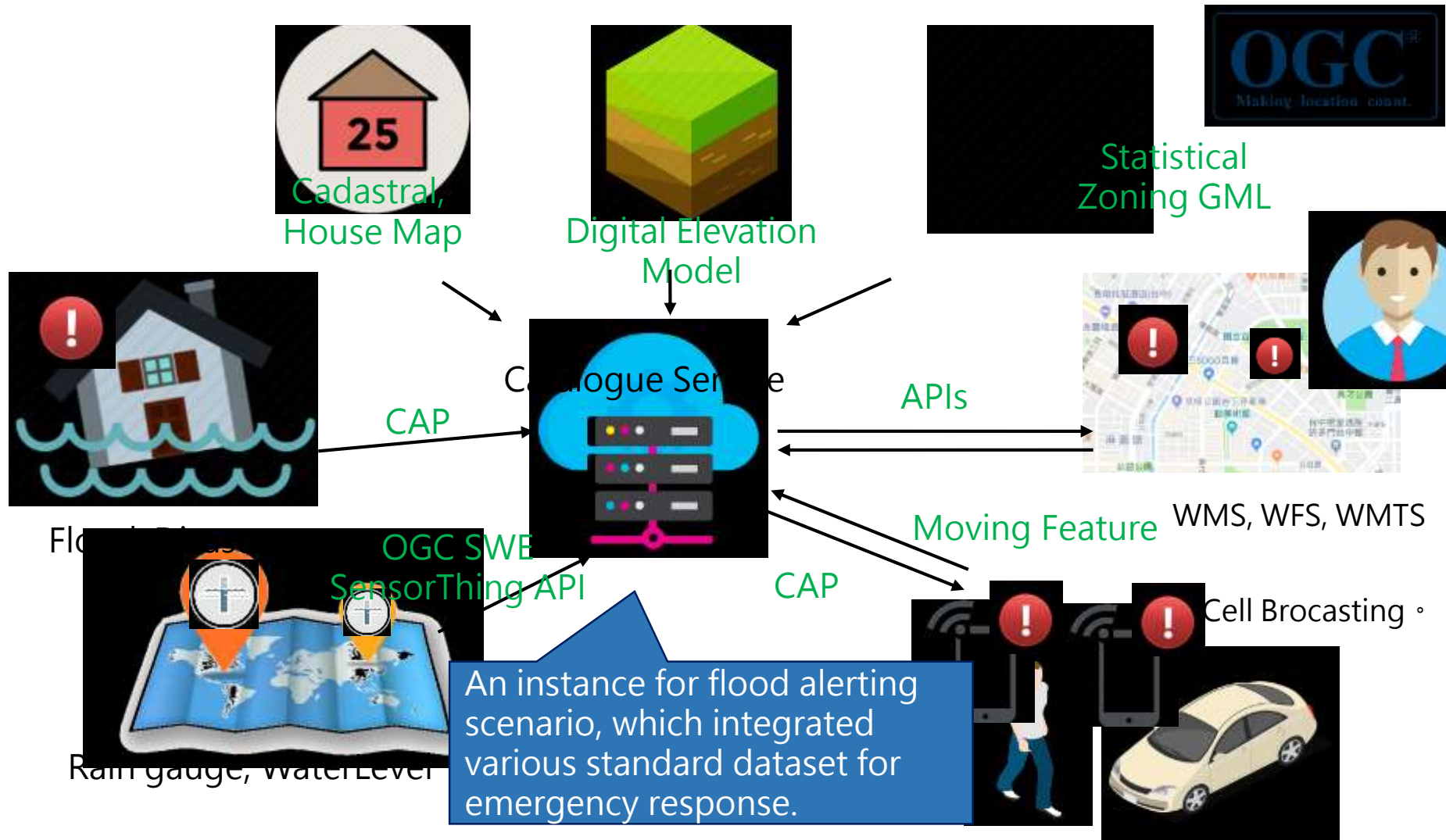


# *What we've concerned*



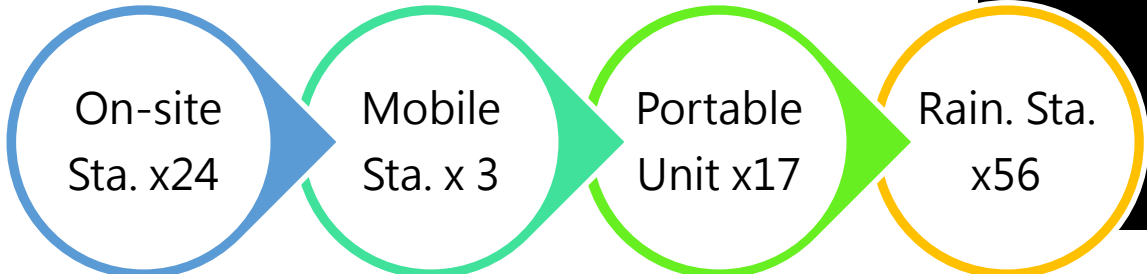
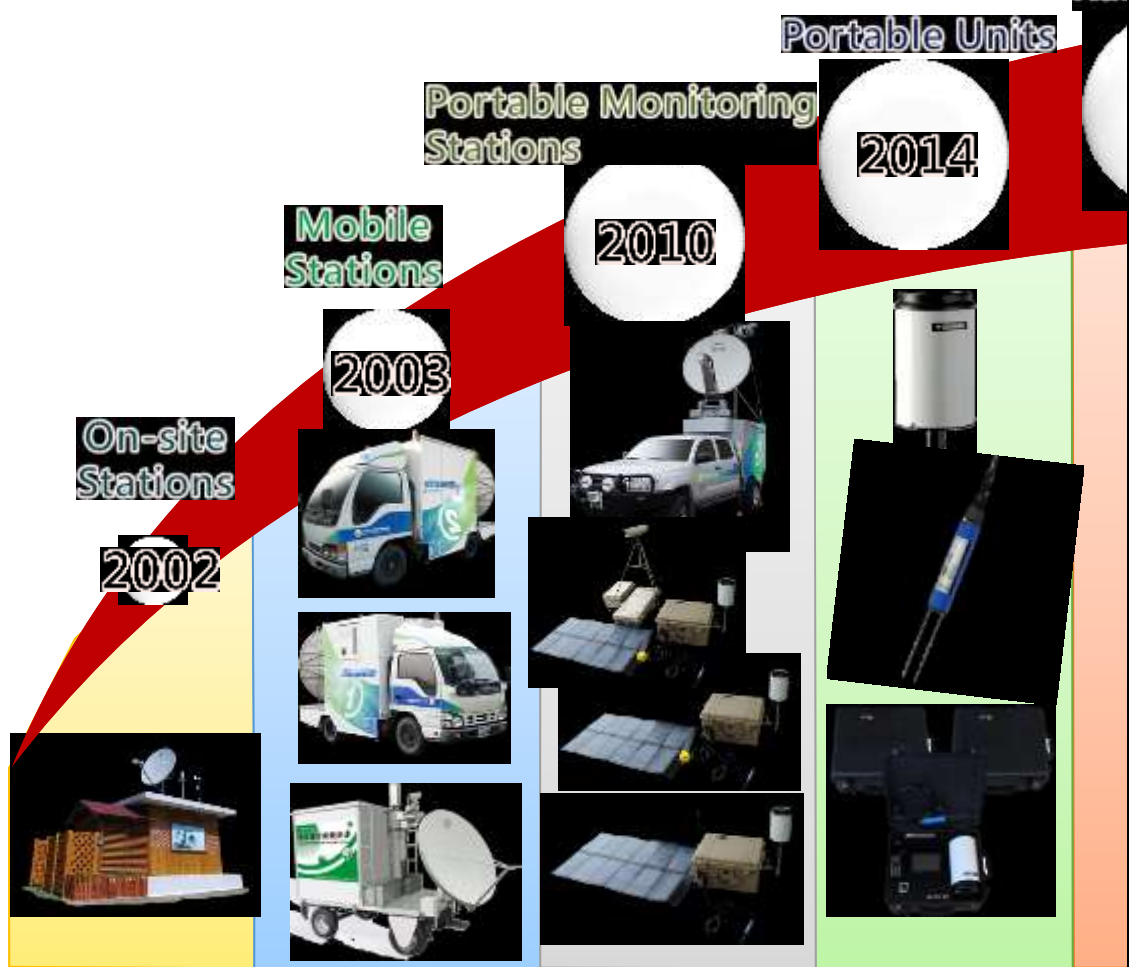
# international standards application

## Dataset Integration based on OGC and ISO Standards



# Slope Land Disaster Monitoring

Rain







## 坪頂觀測站資訊

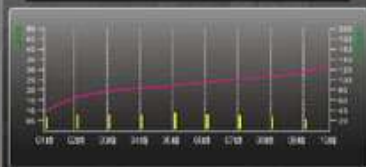
### 伸縮計資訊

伸縮計群組-1	伸縮計群組-2	伸縮計群組-3	伸縮計群組-4
1-1 ● 1 mm	2-1 ● 1 mm	3-1 ● 1 mm	4-1 ● 1 mm
1-2 ● 1 mm	2-2 ● 1 mm		
1-3 ● 1 mm	2-3 ● 1 mm		
1-4 ● 1 mm	2-4 ● 1 mm		

### CCD監測畫面



### 雨量資訊



### 傾度盤資訊

傾度盤 ● 0.1 度

### GPS 資訊

- GPS-1 ● 1 cm
- GPS-2 ● 1 cm
- GPS-3 ● 1 cm
- GPS-4 ● 1 cm
- GPS-5 ● 1 cm

# Implementation in monitoring service platform

## Service

按一下 [這裡](#) 以取得完整的作業清單。

## RequestSOS

### 測試

若要以 HTTP POST 通訊協定測試作業，請按一下 [叫用] 按鈕。

參數	值
requestXML:	<input type="text"/>

叫用

### SOAP 1.1

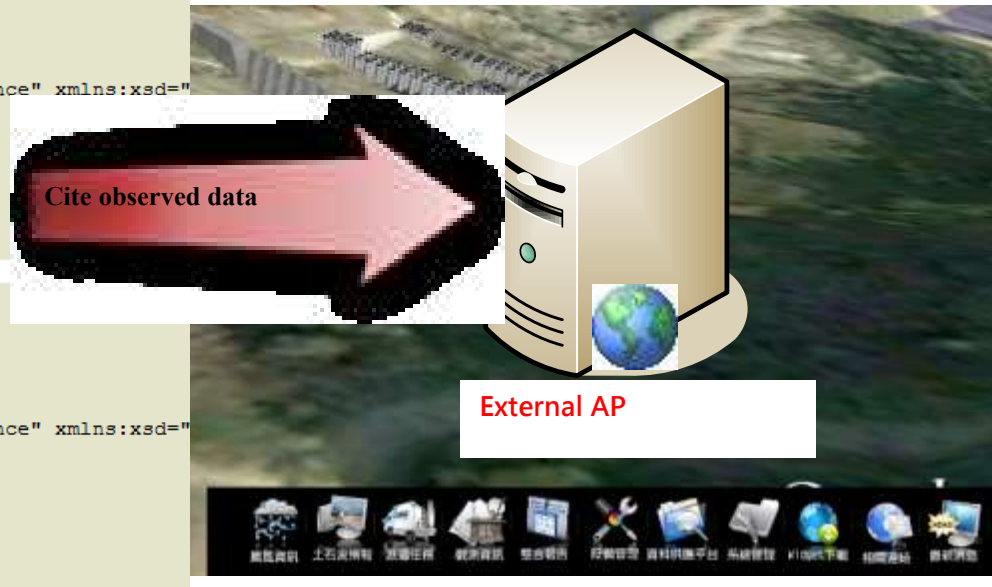
下列是 SOAP 1.1 要求與回應的範例。預留位置顯示之處必須代入實際的值。

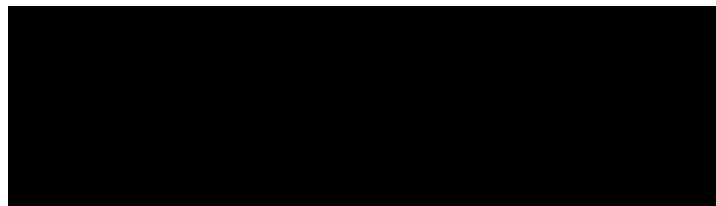
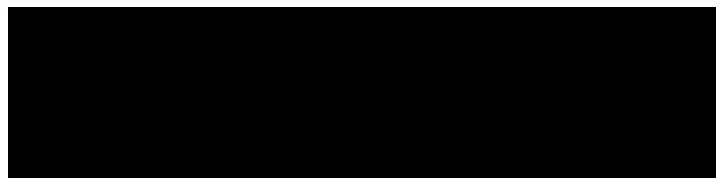
```
POST /FCU_GIS_SOS/Service.asmx HTTP/1.1
Host: 210.241.45.102
Content-Type: text/xml; charset=utf-8
Content-Length: length
SOAPAction: "http://www.gis.fcu.edu.tw/RequestSOS"
```

```
<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="
  <soap:Body>
    <RequestSOS xmlns="http://www.gis.fcu.edu.tw/">
      <requestXML>string</requestXML>
    </RequestSOS>
  </soap:Body>
</soap:Envelope>
```

```
HTTP/1.1 200 OK
Content-Type: text/xml; charset=utf-8
Content-Length: length
```

```
<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="
  <soap:Body>
    <RequestSOSResponse xmlns="http://www.gis.fcu.edu.tw/">
      <RequestSOSResult>xml</RequestSOSResult>
    </RequestSOSResponse>
  </soap:Body>
</soap:Envelope>
```





# Intelligent Municipal Governance

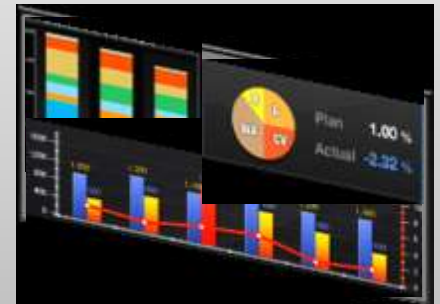
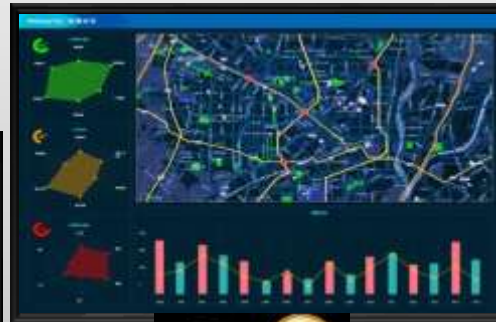


## Dashboard



- Analyzing **big data** to explore people needs and solve problems. Adjust the municipal planning and policies based on data analyses.
- Meet people needs and drive the innovation to raise the public satisfaction.
- Establish the platform to share open data and encourage citizens to add values for applications.

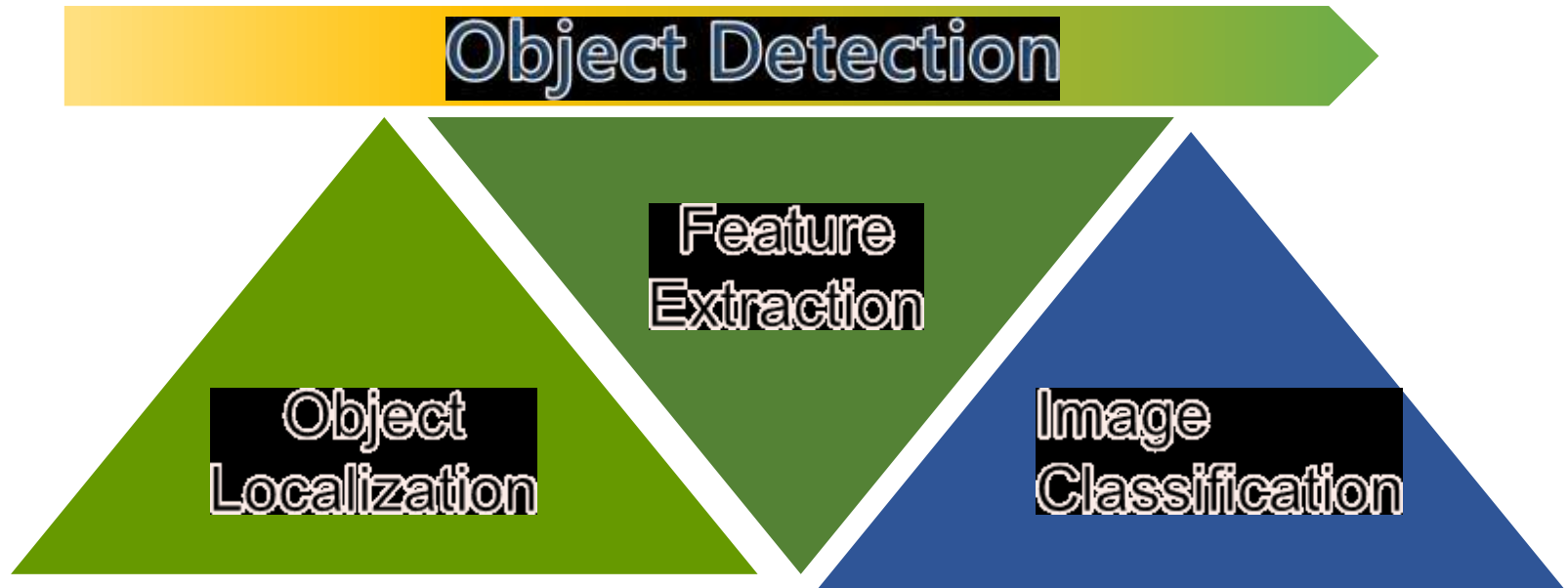
## Intelligent Operation Center



# Real-time Information on Dashboard

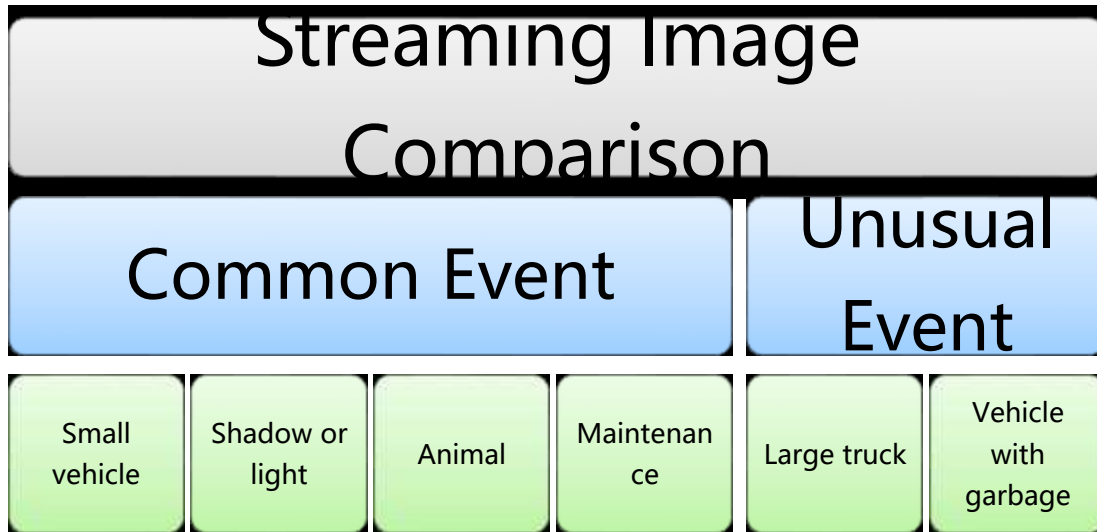


# object detection from deep learning process





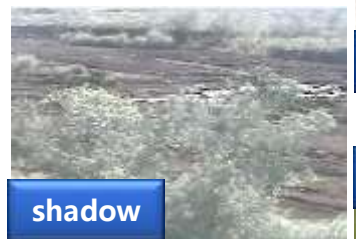
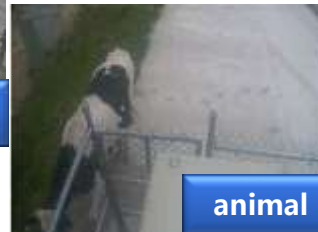
# Remotely Monitoring Center



Record the event



Notify Authority



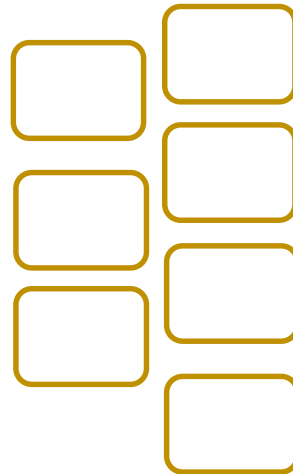


# Artificial Intelligence

Step1:  
Camera will take series pictures if changes are detected

Step2: Event Recognition Module

Step3:  
Alert



# Image training model

## Training



Feature

Label

Training

A yellow arrow pointing from the feature and label boxes to the YOLO Model box.

YOLO Model

## Recognition



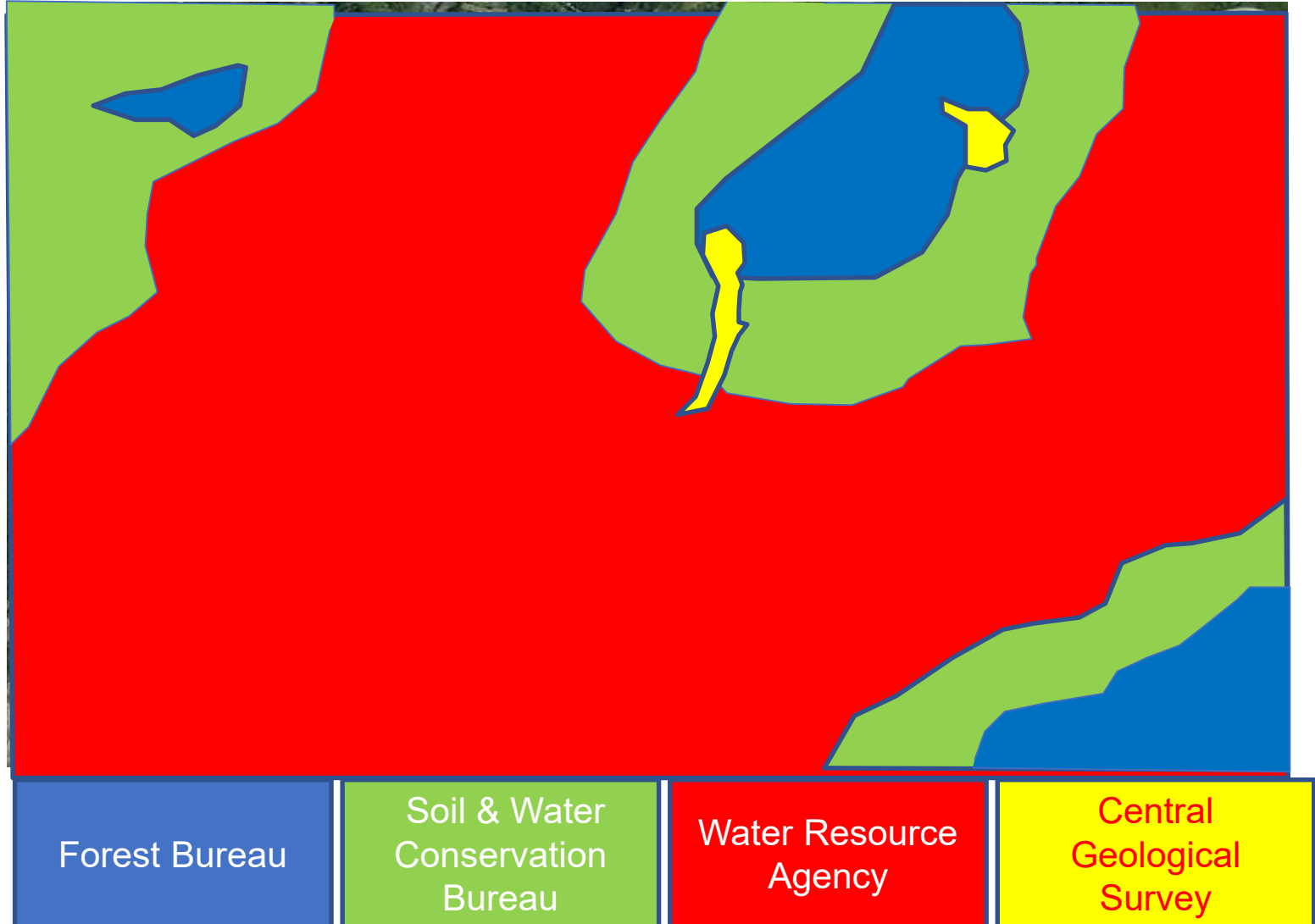
Feature

YOLO model

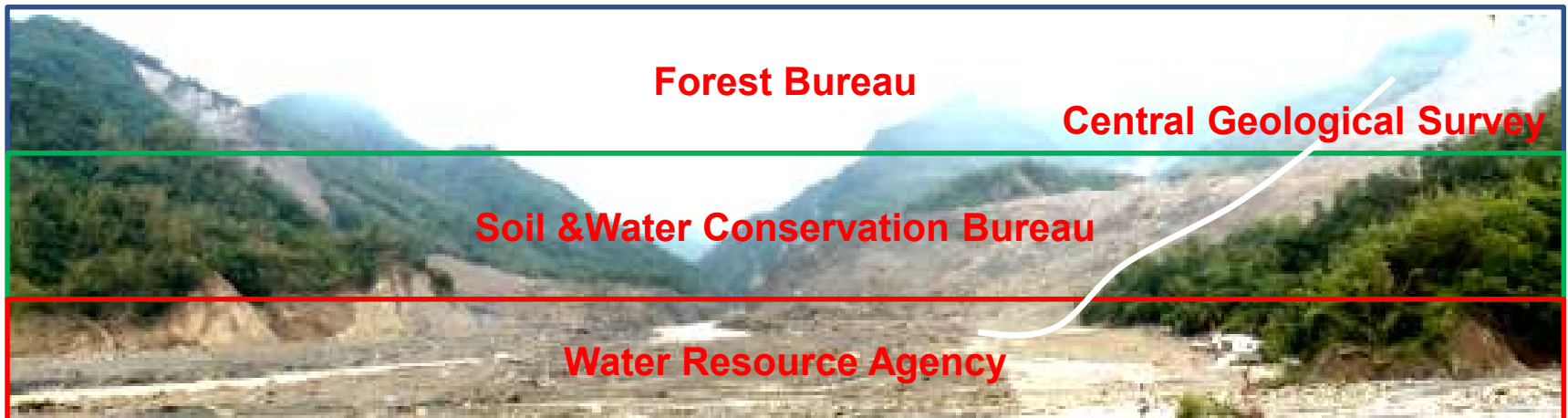
predict

A yellow arrow pointing from the YOLO model box to the recognition image.

# The urgent need for Interoperability between agencies



# Disaster does not matter that much...



**Forest Bureau**

**Central Geological Survey**

**Soil & Water Conservation Bureau**

**Water Resource Agency**



### Administrative interfaces

1. Forest Bureau
2. SWCB
3. Water Resource Agent

### Publishing Interface

1. CSV(various schema)
2. Database
3. OGC SOS
4. Data logger
5. ....

### Maps Interfaces

1. Shape file
2. Geo-database
3. DWG/DGN
4. WMS/WFS

Why don't you speak in the same LANGUAGE???

### Sensors Interface

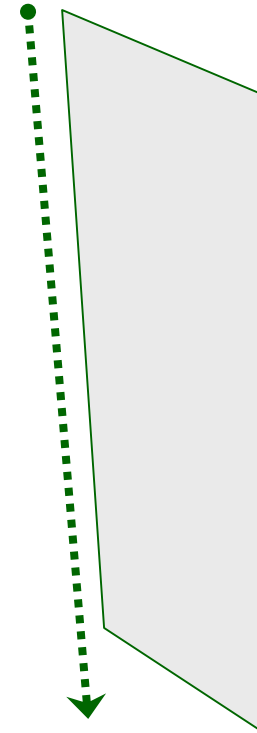
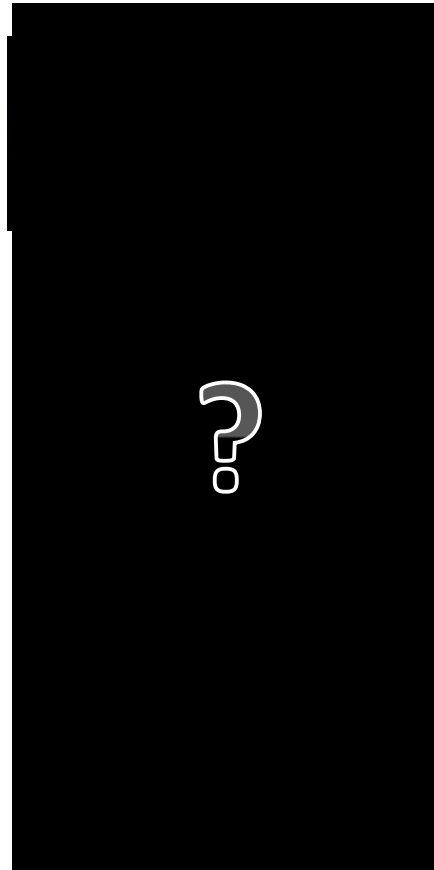
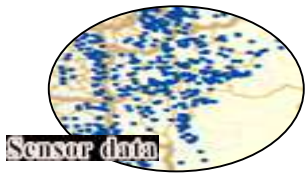
1. Rain Gauge
2. Camera
3. Water level
4. Geophone...

Give me nothing But **Standards** Interoperability

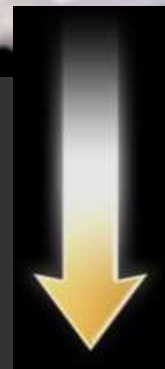


# What we confront with

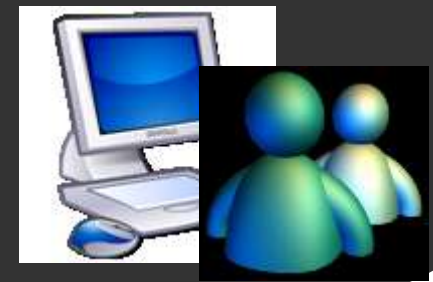
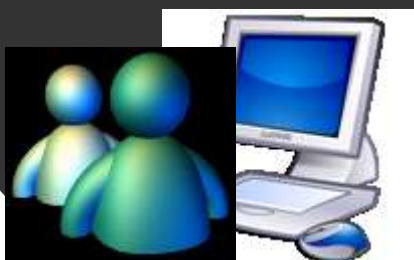
**A great quantity of heterogeneous data vs. low quality of process efficiency**



# Challenges



- Various types of sensors
- Data communication in between
- Data format in exchange
- Real-time requests and responses



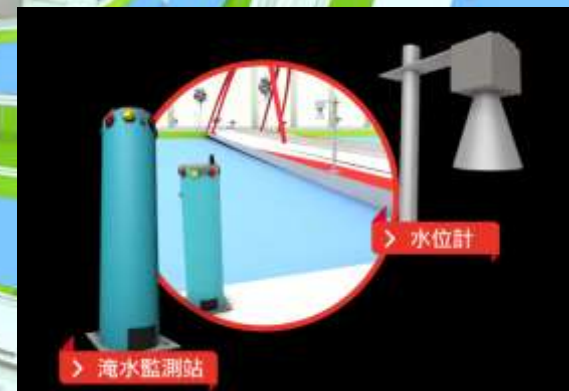
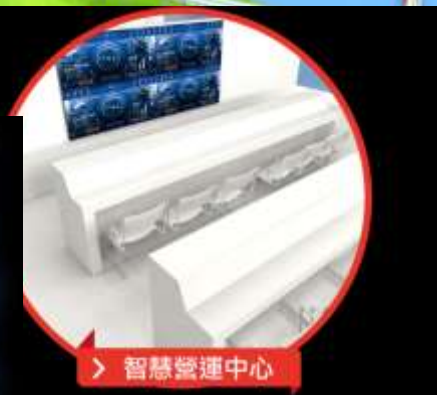
# Internet of Things

## R & D

- Sensor R&D
- Installation and Maintenance
- Customized Design



> 行動式觀測車

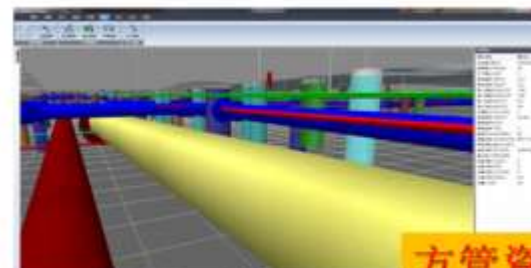
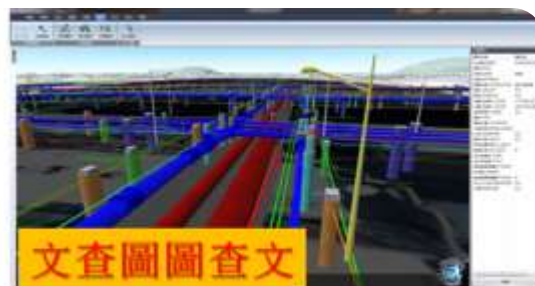
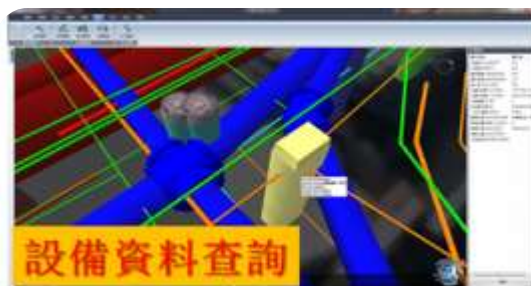


## Integration

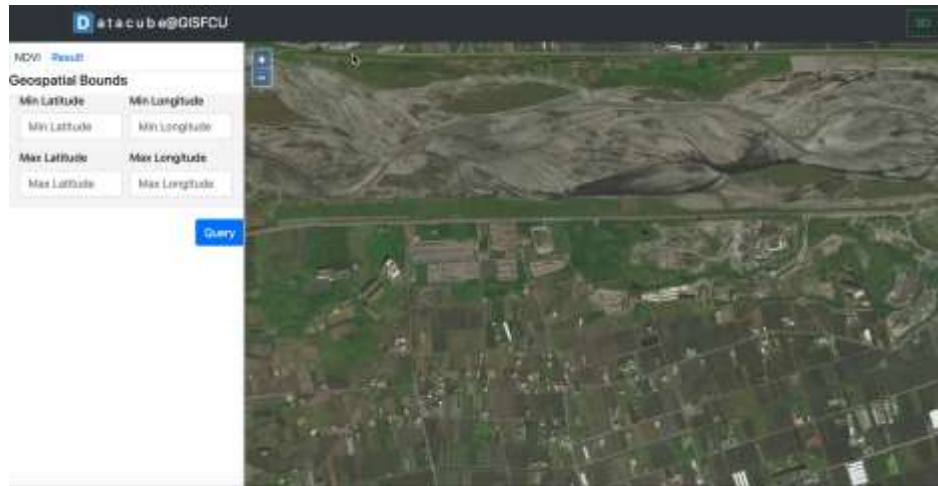
- Monitoring Cloud
- Smart Operation Center
- Info Integration







# Taiwan Data Cube



**NAR Labs** 國家高職研究院  
**國家太空中心**  
National Space Organization

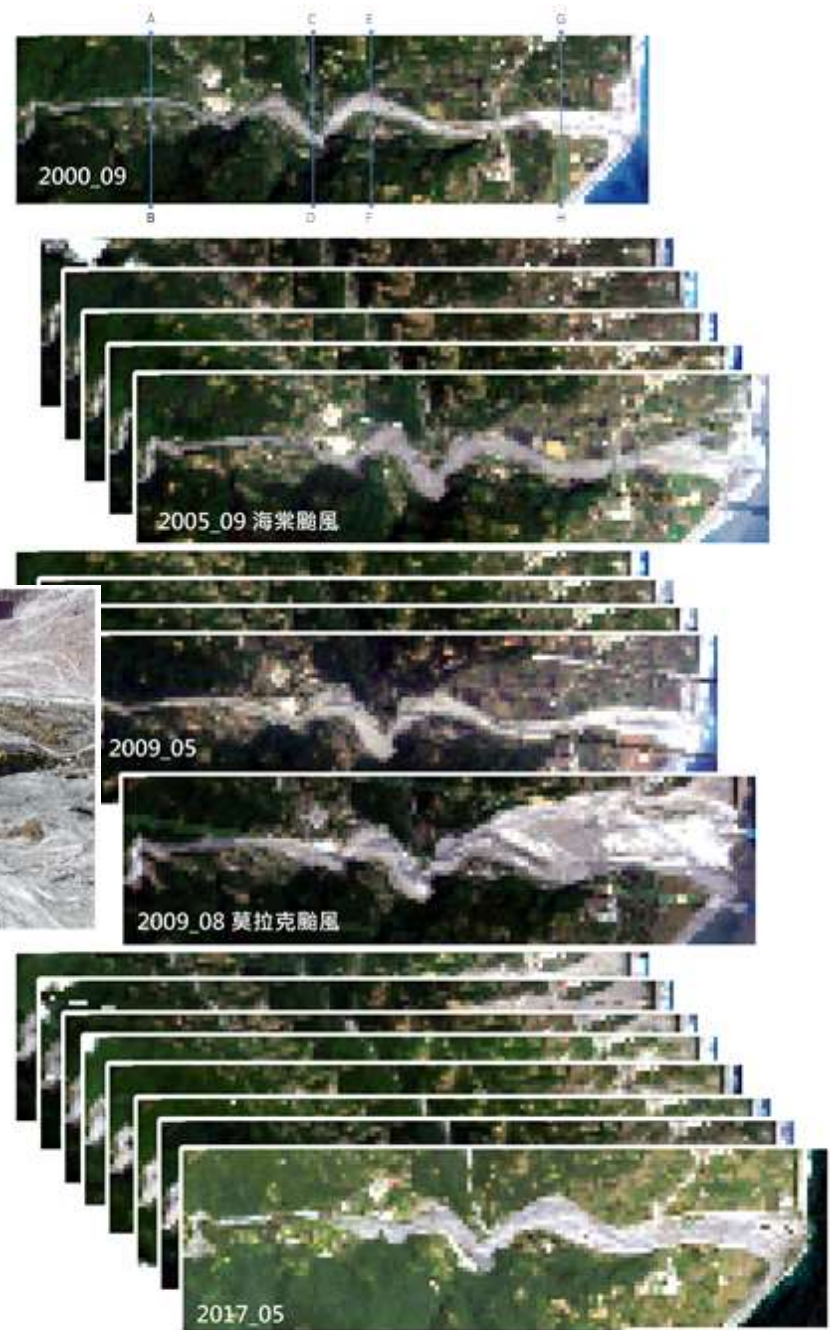
**NAR Labs**  
National Applied Research Laboratories  
National Center for High-performance Computing

- Analysis Ready Data
- Formosa-II, V image ingestion



<http://odc.colife.org.tw/>

# Multi-dimension RS Images



# Link vegetation indices with ground inventory data

2013



2009

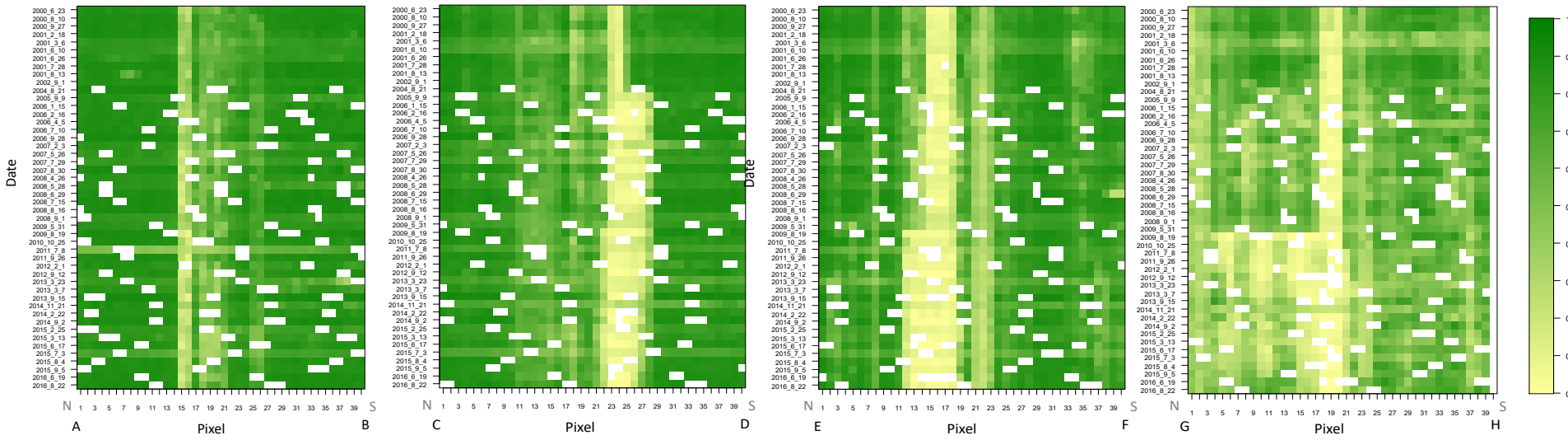
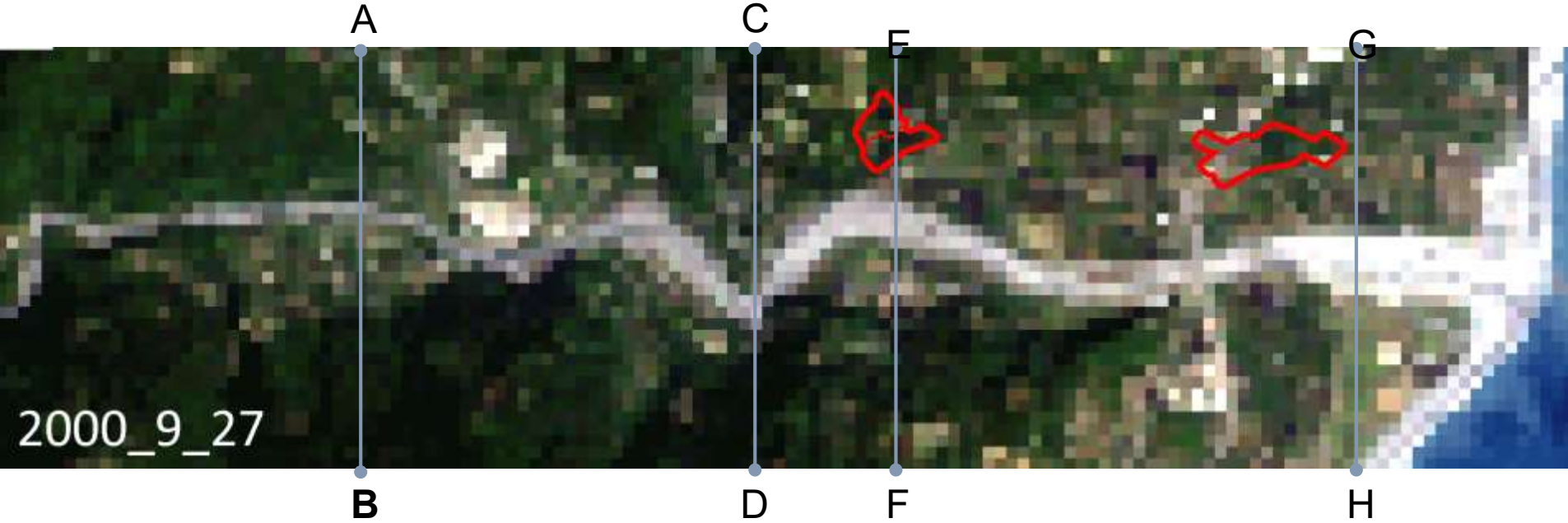
Block	Year	Tree	Height	DBH	Species	...
1	2009	1	10.5	12.5	Pinus	...
1	2009	2	8.2	10.1	Quercus	...
1	2009	3	12.1	14.3	Pinus	...
1	2009	4	9.8	11.2	Quercus	...
1	2009	5	11.5	13.7	Pinus	...
1	2009	6	10.2	12.8	Pinus	...
1	2009	7	13.4	15.6	Pinus	...
1	2009	8	11.8	14.1	Pinus	...
1	2009	9	10.7	12.9	Pinus	...
1	2009	10	12.3	14.5	Pinus	...
1	2009	11	11.1	13.2	Pinus	...
1	2009	12	10.4	12.6	Pinus	...
1	2009	13	12.8	15.1	Pinus	...
1	2009	14	11.6	14.0	Pinus	...
1	2009	15	10.9	13.0	Pinus	...
1	2009	16	12.5	14.8	Pinus	...
1	2009	17	11.3	13.5	Pinus	...
1	2009	18	10.6	12.7	Pinus	...
1	2009	19	12.2	14.6	Pinus	...
1	2009	20	11.0	13.3	Pinus	...
1	2009	21	10.3	12.5	Pinus	...
1	2009	22	12.7	15.0	Pinus	...
1	2009	23	11.5	13.9	Pinus	...
1	2009	24	10.8	12.9	Pinus	...
1	2009	25	12.4	14.7	Pinus	...
1	2009	26	11.2	13.6	Pinus	...
1	2009	27	10.5	12.6	Pinus	...
1	2009	28	12.1	14.5	Pinus	...
1	2009	29	10.9	13.2	Pinus	...
1	2009	30	12.6	14.9	Pinus	...
1	2009	31	11.4	13.8	Pinus	...
1	2009	32	10.7	12.8	Pinus	...
1	2009	33	12.3	14.6	Pinus	...
1	2009	34	11.1	13.4	Pinus	...
1	2009	35	10.4	12.5	Pinus	...
1	2009	36	12.0	14.4	Pinus	...
1	2009	37	10.8	13.1	Pinus	...
1	2009	38	12.5	14.8	Pinus	...
1	2009	39	11.3	13.7	Pinus	...
1	2009	40	10.6	12.7	Pinus	...
1	2009	41	12.2	14.5	Pinus	...
1	2009	42	11.0	13.3	Pinus	...
1	2009	43	10.3	12.5	Pinus	...
1	2009	44	12.7	15.0	Pinus	...
1	2009	45	11.5	13.9	Pinus	...
1	2009	46	10.8	12.9	Pinus	...
1	2009	47	12.4	14.7	Pinus	...
1	2009	48	11.2	13.6	Pinus	...
1	2009	49	10.5	12.6	Pinus	...
1	2009	50	12.1	14.5	Pinus	...
1	2009	51	10.9	13.2	Pinus	...
1	2009	52	12.6	14.9	Pinus	...
1	2009	53	11.4	13.8	Pinus	...
1	2009	54	10.7	12.8	Pinus	...
1	2009	55	12.3	14.6	Pinus	...
1	2009	56	11.1	13.4	Pinus	...
1	2009	57	10.4	12.5	Pinus	...
1	2009	58	12.0	14.4	Pinus	...
1	2009	59	10.8	13.1	Pinus	...
1	2009	60	12.5	14.8	Pinus	...
1	2009	61	11.3	13.7	Pinus	...
1	2009	62	10.6	12.7	Pinus	...
1	2009	63	12.2	14.5	Pinus	...
1	2009	64	11.0	13.3	Pinus	...
1	2009	65	10.3	12.5	Pinus	...
1	2009	66	12.7	15.0	Pinus	...
1	2009	67	11.5	13.9	Pinus	...
1	2009	68	10.8	12.9	Pinus	...
1	2009	69	12.4	14.7	Pinus	...
1	2009	70	11.2	13.6	Pinus	...
1	2009	71	10.5	12.6	Pinus	...
1	2009	72	12.1	14.5	Pinus	...
1	2009	73	10.9	13.2	Pinus	...
1	2009	74	12.6	14.9	Pinus	...
1	2009	75	11.4	13.8	Pinus	...
1	2009	76	10.7	12.8	Pinus	...
1	2009	77	12.3	14.6	Pinus	...
1	2009	78	11.1	13.4	Pinus	...
1	2009	79	10.4	12.5	Pinus	...
1	2009	80	12.0	14.4	Pinus	...
1	2009	81	10.8	13.1	Pinus	...
1	2009	82	12.5	14.8	Pinus	...
1	2009	83	11.3	13.7	Pinus	...
1	2009	84	10.6	12.7	Pinus	...
1	2009	85	12.2	14.5	Pinus	...
1	2009	86	11.0	13.3	Pinus	...
1	2009	87	10.3	12.5	Pinus	...
1	2009	88	12.7	15.0	Pinus	...
1	2009	89	11.5	13.9	Pinus	...
1	2009	90	10.8	12.9	Pinus	...
1	2009	91	12.4	14.7	Pinus	...
1	2009	92	11.2	13.6	Pinus	...
1	2009	93	10.5	12.6	Pinus	...
1	2009	94	12.1	14.5	Pinus	...
1	2009	95	10.9	13.2	Pinus	...
1	2009	96	12.6	14.9	Pinus	...
1	2009	97	11.4	13.8	Pinus	...
1	2009	98	10.7	12.8	Pinus	...
1	2009	99	12.3	14.6	Pinus	...
1	2009	100	11.1	13.4	Pinus	...

2010

Block	Year	Tree	Height	DBH	Species	...
1	2010	1	10.5	12.5	Pinus	...
1	2010	2	8.2	10.1	Quercus	...
1	2010	3	12.1	14.3	Pinus	...
1	2010	4	9.8	11.2	Quercus	...
1	2010	5	11.5	13.7	Pinus	...
1	2010	6	10.2	12.8	Pinus	...
1	2010	7	13.4	15.6	Pinus	...
1	2010	8	11.8	14.1	Pinus	...
1	2010	9	10.7	12.9	Pinus	...
1	2010	10	12.3	14.5	Pinus	...
1	2010	11	11.1	13.2	Pinus	...
1	2010	12	10.4	12.6	Pinus	...
1	2010	13	12.8	15.1	Pinus	...
1	2010	14	11.6	14.0	Pinus	...
1	2010	15	10.9	13.0	Pinus	...
1	2010	16	12.5	14.8	Pinus	...
1	2010	17	11.3	13.5	Pinus	...
1	2010	18	10.6	12.7	Pinus	...
1	2010	19	12.2	14.6	Pinus	...
1	2010	20	11.0	13.3	Pinus	...
1	2010	21	10.3	12.5	Pinus	...
1	2010	22	12.7	15.0	Pinus	...
1	2010	23	11.5	13.9	Pinus	...
1	2010	24	10.8	12.9	Pinus	...
1	2010	25	12.4	14.7	Pinus	...
1	2010	26	11.2	13.6	Pinus	...
1	2010	27	10.5	12.6	Pinus	...
1	2010	28	12.1	14.5	Pinus	...
1	2010	29	10.9	13.2	Pinus	...
1	2010	30	12.6	14.9	Pinus	...
1	2010	31	11.4	13.8	Pinus	...
1	2010	32	10.7	12.8	Pinus	...
1	2010	33	12.3	14.6	Pinus	...
1	2010	34	11.1	13.4	Pinus	...
1	2010	35	10.4	12.5	Pinus	...
1	2010	36	12.0	14.4	Pinus	...
1	2010	37	10.8	13.1	Pinus	...
1	2010	38	12.5	14.8	Pinus	...
1	2010	39	11.3	13.7	Pinus	...
1	2010	40	10.6	12.7	Pinus	...
1	2010	41	12.2	14.5	Pinus	...
1	2010	42	11.0	13.3	Pinus	...
1	2010	43	10.3	12.5	Pinus	...
1	2010	44	12.7	15.0	Pinus	...
1	2010	45	11.5	13.9	Pinus	...
1	2010	46	10.8	12.9	Pinus	...
1	2010	47	12.4	14.7	Pinus	...
1	2010	48	11.2	13.6	Pinus	...
1	2010	49	10.5	12.6	Pinus	...
1	2010	50	12.1	14.5	Pinus	...
1	2010	51	10.9	13.2	Pinus	...
1	2010	52	12.6	14.9	Pinus	...
1	2010	53	11.4	13.8	Pinus	...
1	2010	54	10.7	12.8	Pinus	...
1	2010	55	12.3	14.6	Pinus	...
1	2010	56	11.1	13.4	Pinus	...
1	2010	57	10.4	12.5	Pinus	...
1	2010	58	12.0	14.4	Pinus	...
1	2010	59	10.8	13.1	Pinus	...
1	2010	60	12.5	14.8	Pinus	...
1	2010	61	11.3	13.7	Pinus	...
1	2010	62	10.6	12.7	Pinus	...
1	2010	63	12.2	14.5	Pinus	...
1	2010	64	11.0	13.3	Pinus	...
1	2010	65	10.3	12.5	Pinus	...
1	2010	66	12.7	15.0	Pinus	...
1	2010	67	11.5	13.9	Pinus	...
1	2010	68	10.8	12.9	Pinus	...
1	2010	69	12.4	14.7	Pinus	...
1	2010	70	11.2	13.6	Pinus	...
1	2010	71	10.5	12.6	Pinus	...
1	2010	72	12.1	14.5	Pinus	...
1	2010	73	10.9	13.2	Pinus	...
1	2010	74	12.6	14.9	Pinus	...
1	2010	75	11.4	13.8	Pinus	...
1	2010	76	10.7	12.8	Pinus	...
1	2010	77	12.3	14.6	Pinus	...
1	2010	78	11.1	13.4	Pinus	...
1	2010	79	10.4	12.5	Pinus	...
1	2010	80	12.0	14.4	Pinus	...
1	2010	81	10.8	13.1	Pinus	...
1	2010	82	12.5	14.8	Pinus	...
1	2010	83	11.3	13.7	Pinus	...
1	2010	84	10.6	12.7	Pinus	...
1	2010	85	12.2	14.5	Pinus	...
1	2010	86	11.0	13.3	Pinus	...
1	2010	87	10.3	12.5	Pinus	...
1	2010	88	12.7	15.0	Pinus	...
1	2010	89	11.5	13.9	Pinus	...
1	2010	90	10.8	12.9	Pinus	...
1	2010	91	12.4	14.7	Pinus	...
1	2010	92	11.2	13.6	Pinus	...
1	2010	93	10.5	12.6	Pinus	...
1	2010	94	12.1	14.5	Pinus	...
1	2010	95	10.9	13.2	Pinus	...
1	2010	96	12.6	14.9	Pinus	...
1	2010	97	11.4	13.8	Pinus	...
1	2010	98	10.7	12.8	Pinus	...
1	2010	99	12.3	14.6	Pinus	...
1	2010	100	11.1	13.4	Pinus	...

Block	Year	Tree	Height	DBH	Species	...
1	2013	1	10.5	12.5	Pinus	...
1	2013	2	8.2	10.1	Quercus	...
1	2013	3	12.1	14.3	Pinus	...
1	2013	4	9.8	11.2	Quercus	...
1	2013	5	11.5	13.7	Pinus	...
1	2013	6	10.2	12.8	Pinus	...
1	2013	7	13.4	15.6	Pinus	...
1	2013	8	11.8	14.1	Pinus	...
1	2013	9	10.7	12.9	Pinus	...
1	2013	10	12.3	14.5	Pinus	...
1	2013	11	11.1	13.2	Pinus	...
1	2013	12	10.4	12.6	Pinus	...
1	2013	13	12.8	15.1	Pinus	...
1						

# NDVI Spatio-temporal Transect analysis



# DataCube



# DataCube





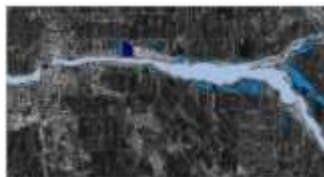


# OGC Testbed-14 on ML/DL Scenario

- Combining satellite, aerial photo for war zone object detection with OGC standards



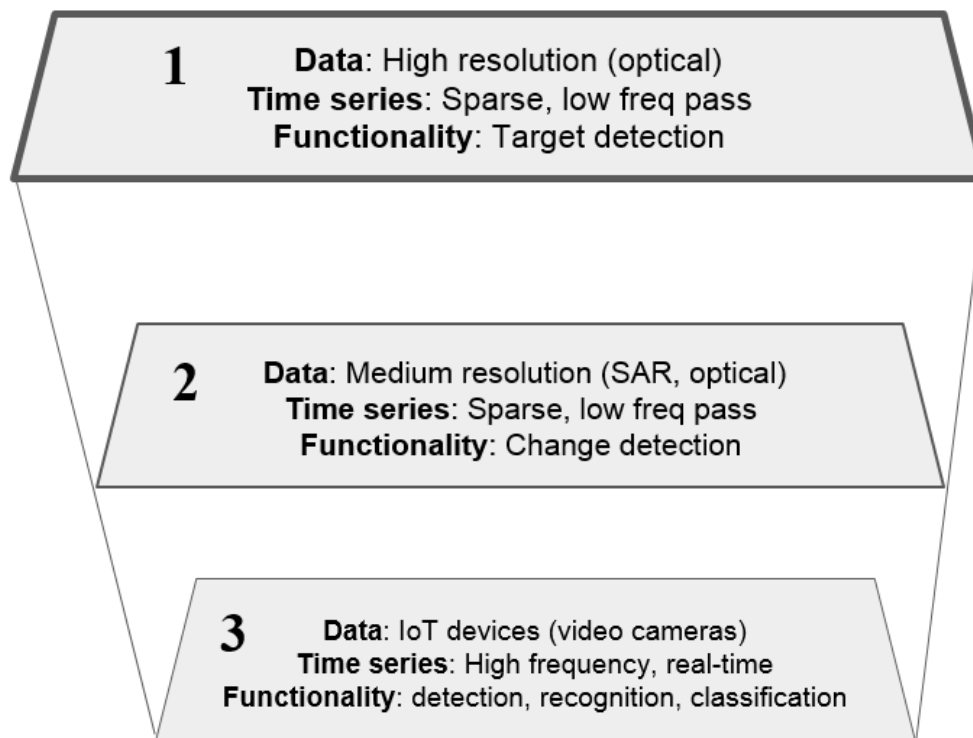
Source: CRIM, Effigis GeoSolutions



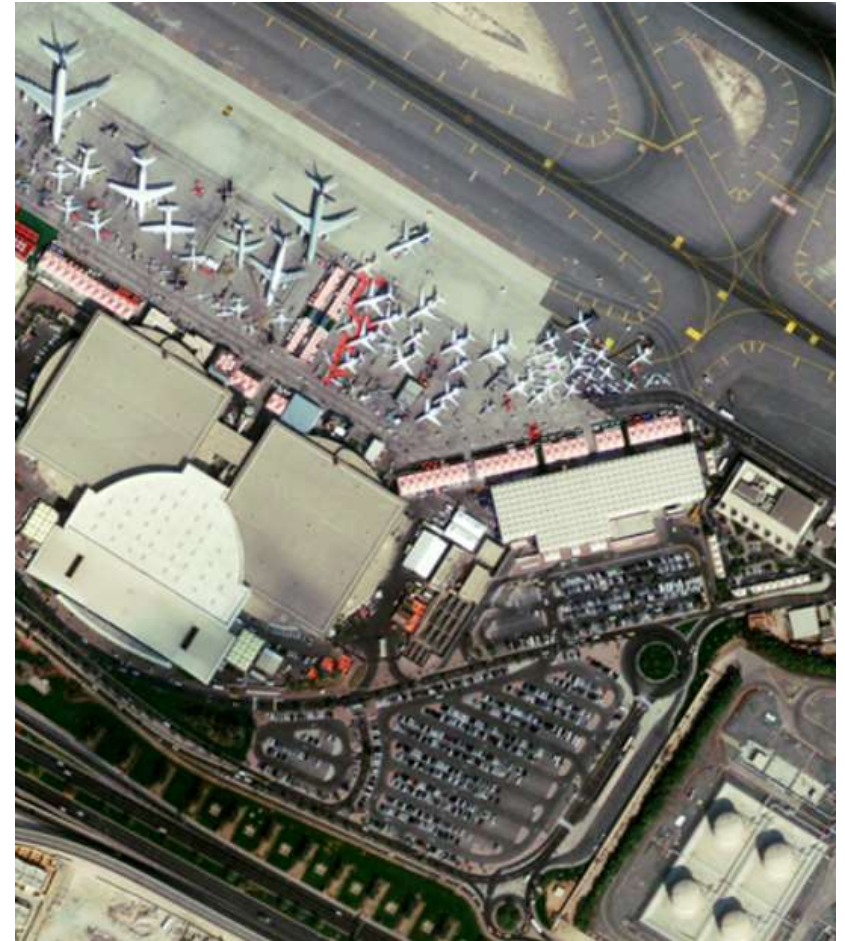
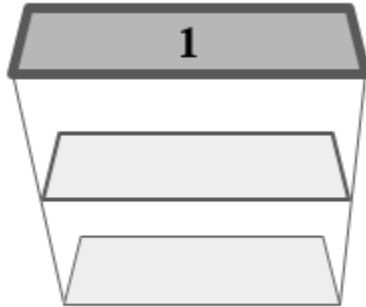
Source: ÉTS, CRIM



Source: YOLO9000

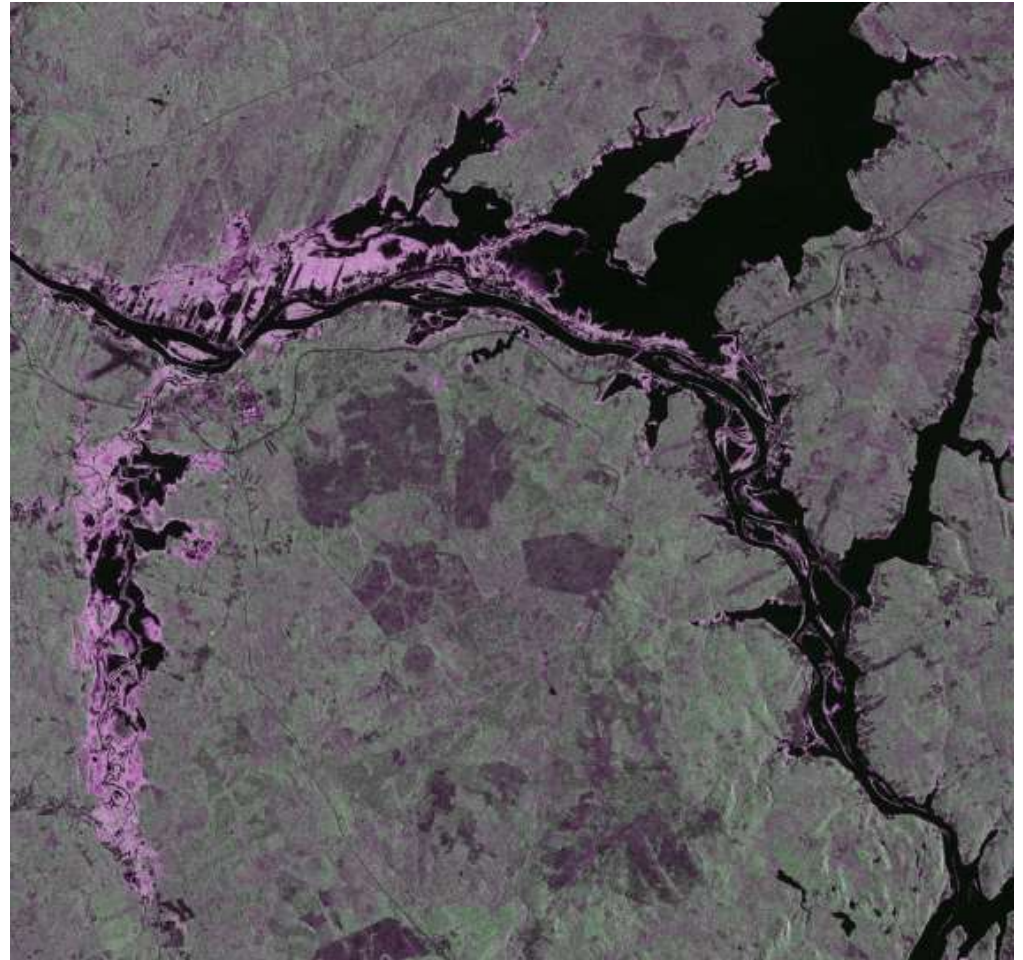
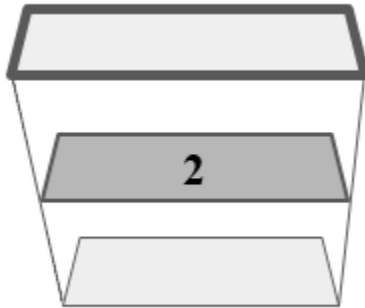


# Geo Layer 1, Pleiades



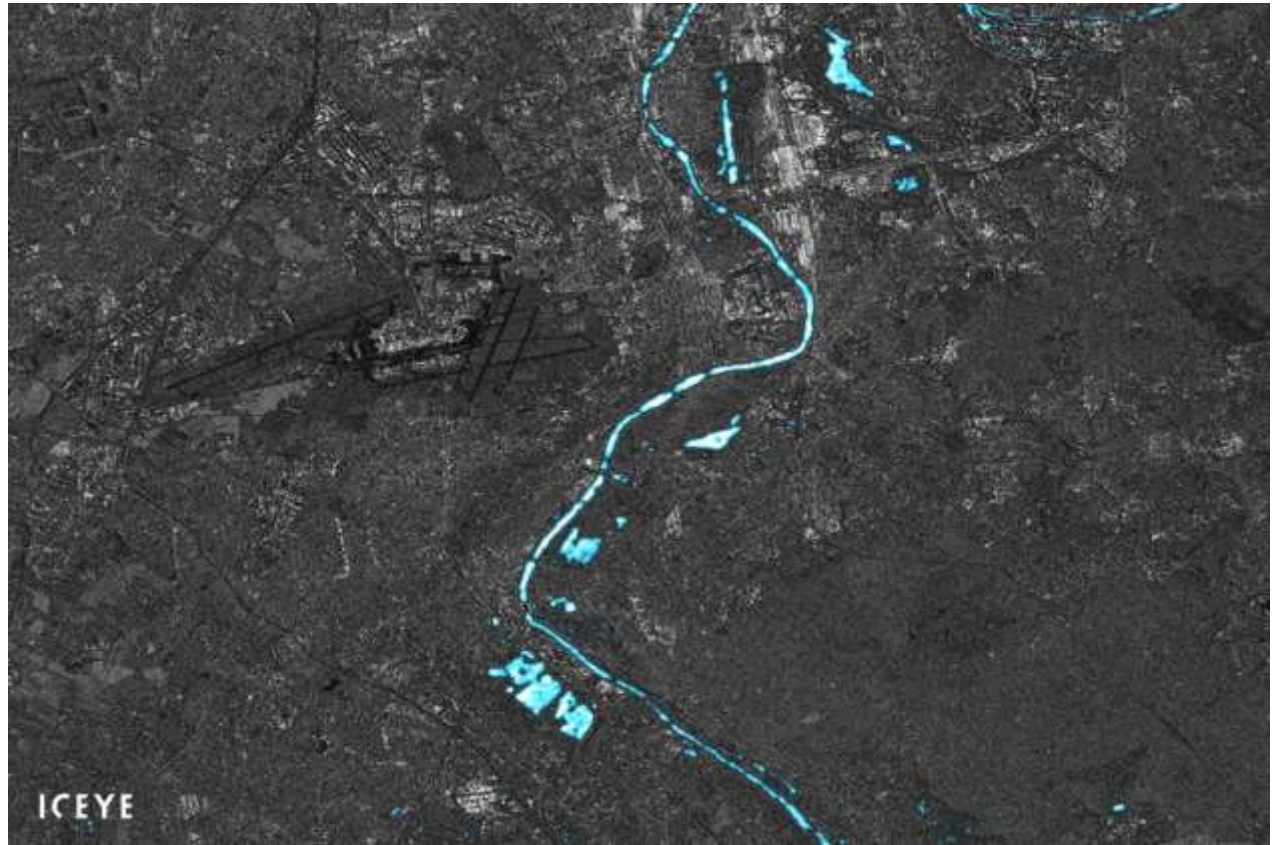
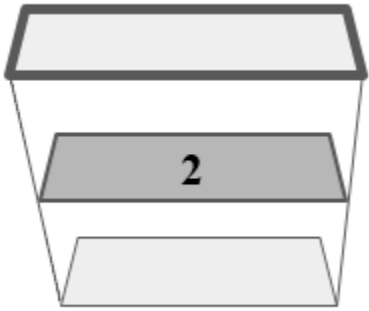
[Source: Effigis GeoSolutions](#)

# Geo Layer 2, RADARSAT-2



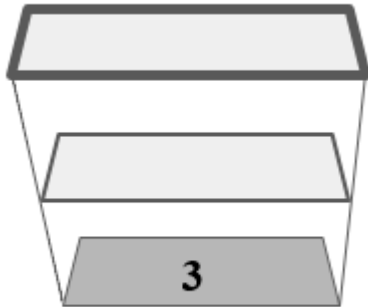
[Source: MDA 2008](#)


# Other layer 2, IceEye



[Source: IceEye, ESA](#)

# Geo Layer 3, video cameras



Montréal 

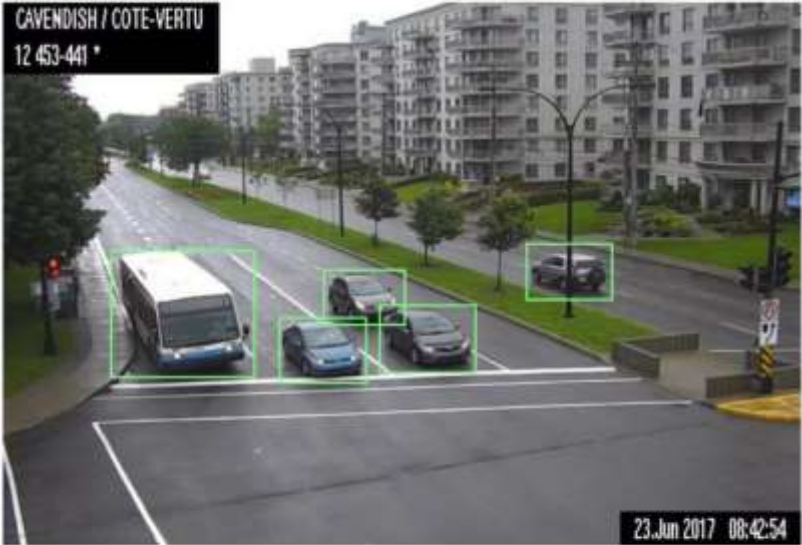
PORTAIL DONNÉES  
OUVERTES

## Annotate objects in the pictures

**Instructions :**  
Draw rectangles over vehicles with more than 2 wheels. There must be one bounding box per vehicle.

**Example:**

CAVENDISH / COTE-VERTU  
12 453-441 \*



23 Jun 2017 08:42:54

Enter your id :

Next

The image shows a street scene with several vehicles. A white bus is on the left, and several cars are in the middle and right lanes. Green bounding boxes are drawn around the bus and three cars. The background shows a multi-story apartment building and trees.

Source: CRIM

# Observations: also a question of wording



- This is a white lorry
- This is a small van
- Are these both medium sized truck?
- Are they the same vehicle?

Source: Airbus Defense and Space

# *Next AI steps of GIS.FCU*

*Software Level*

*AI Technologies*

## **Deep Learning Ecosystem**

<b>Application</b>	<b>AI, Classification, etc</b>	<b>Domain Experts, Production/Solution</b>
<b>Framework</b>	<b><i>Caffe, TensorFlow, etc</i></b>	<b>Open Source Applying Implementation</b>
<b>Library Language</b>	<b><i>cuDNN, OpenCL, etc</i></b>	<b>Model Developing, Academic Research</b>
<b>Hardware</b>	<b>GPU, CPU</b>	<b>Cooperate with National High Performance Center</b>

# Open, Sharing, Communication

Cooperation across Industry, Academy, and Government

## Smiling curve

Value-added Services

