

# Earthquake, Tsunami, Volcano Monitoring & Warning System in Korea

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**Earthquake & Volcano Monitoring Division**  
**KMA**



- 1 Brief History & Vision of KMA**
- 2 Introduction of Services**
- 3 Korea National Seismographic Network**
- 4 Seismicity in Korea**
- 5 Tsunami & Volcano Monitoring**



## SAFE VISION 2020

### VISION

To ensure public safety by minimizing earthquake hazard through earthquake and tsunami monitoring

### MISSION

Accurate earthquake information & prompt notification

#### Strategy 1.

Implementation of National earthquake-tsunami Early Response System

#### Strategy 2.

National earthquake-tsunami response of institutional strengthening

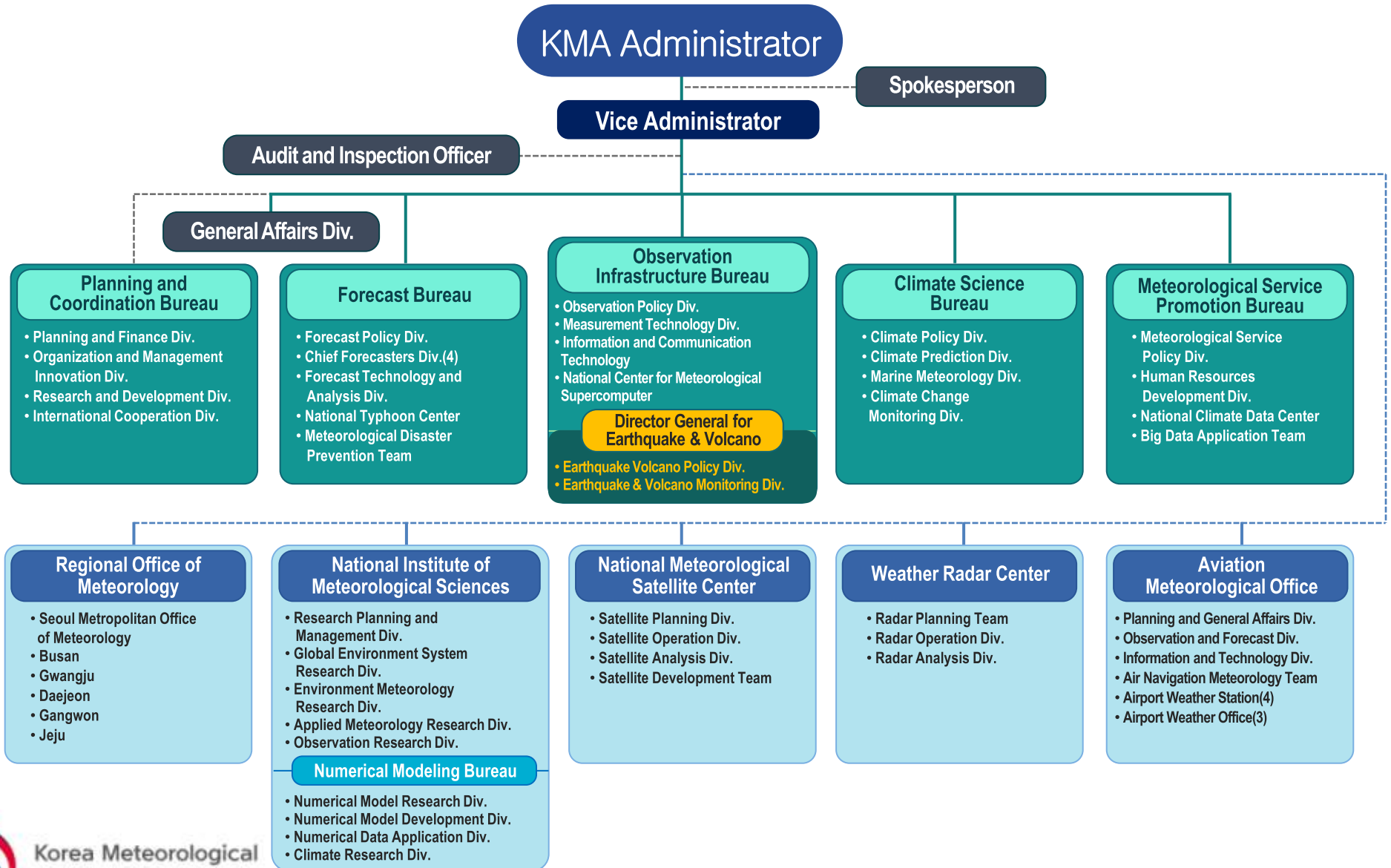
#### Strategy 3.

Goal-oriented long-term technology development





# KMA Organization





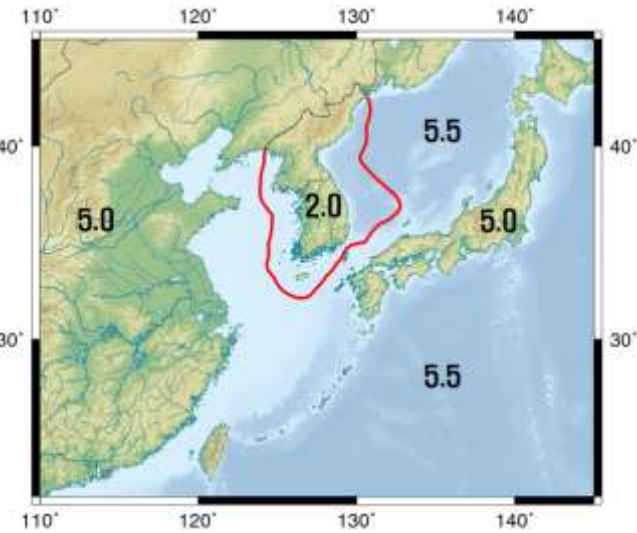
# Brief History of Seismological Services

Year	Contents
<b>1905</b>	<b>Start of earthquake observations</b>
1944~ 1962	Suspension of observation
1963	World-standard seismograph network installed in Seoul
<b>1978</b>	<b>Analog seismic network constructed</b>
1996	Earthquake division was newly established
<b>1999</b>	<b>Digital seismic network constructed</b>
2005	Earthquake division divided into two divisions - Earthquake Planning Division / Earthquake Detection Division
2006	Ocean Bottom Seismometer installed
2007	Earthquake division elevated to Bureau level - Director General for Earthquake appointed
2015	Current Status - 1 Director-General, 2 divisions, 1 laboratory





## Domestic Earthquakes

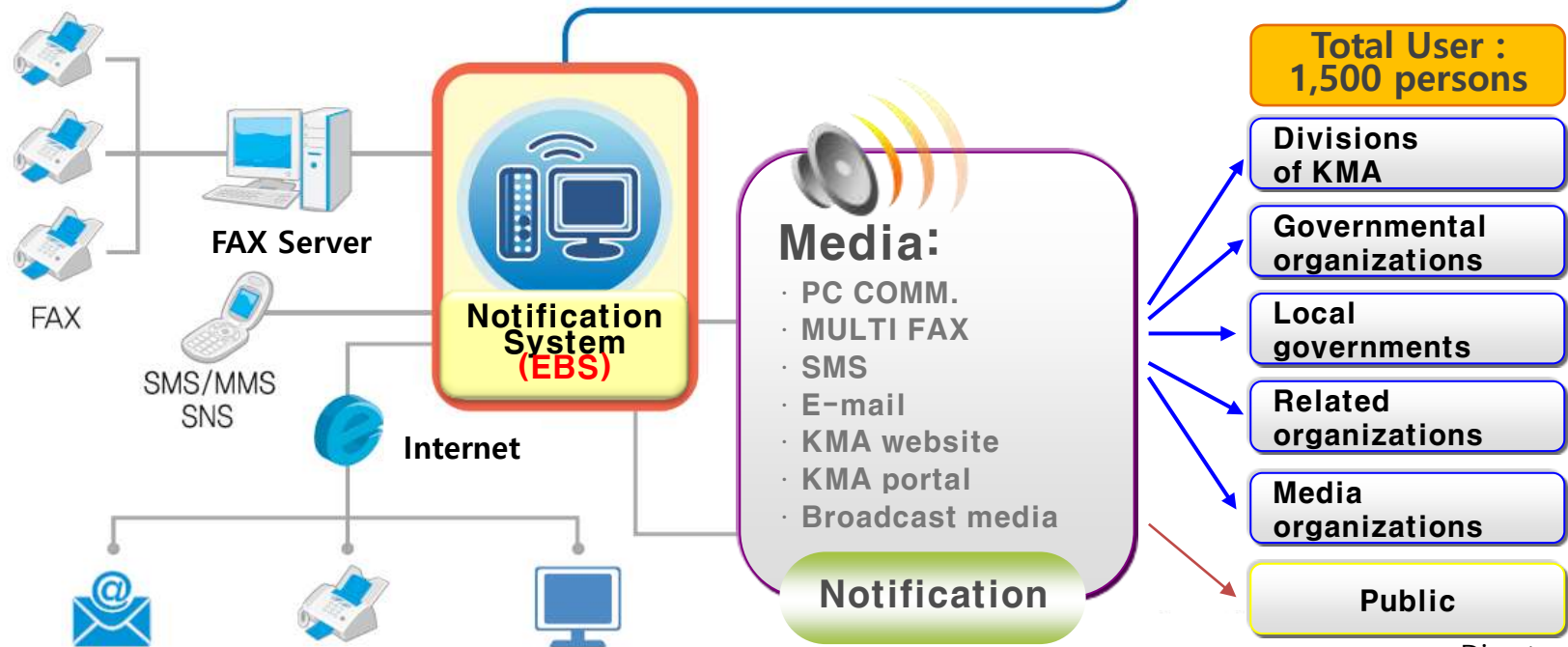
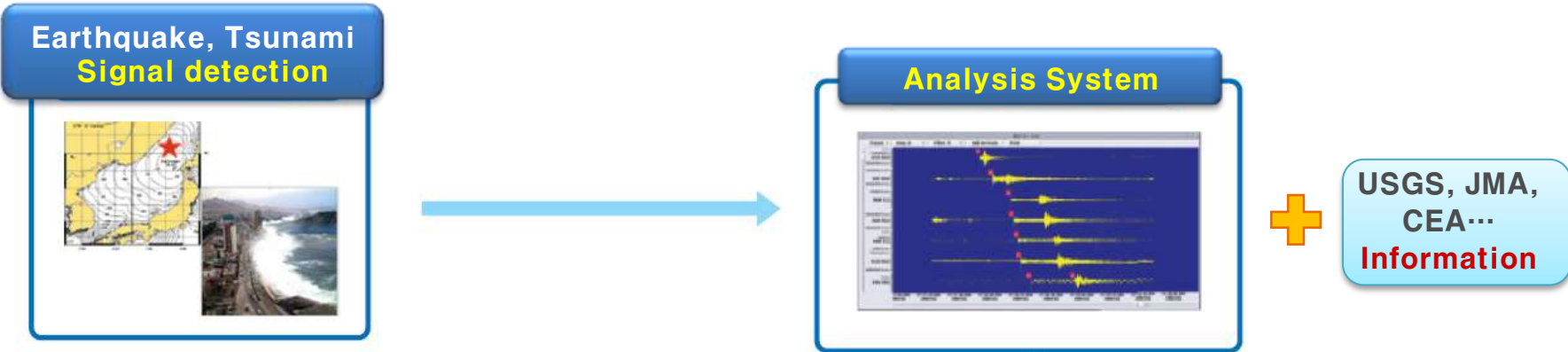


Alerts	Magnitude		Time
	Inland	ML ≥ 3.5	
Earthquake Flash	Ocean area	ML ≥ 4.0	Within 2 min.
	-	ML ≥ 2.0	
Earthquake Information	-	ML ≥ 2.0	Within 5 min.
Early Earthquake Warning	-	ML ≥ 5.0	Within 50 Sec.

## Tsunami

What	When	Time
Tsunami Watch	ML ≥ 7.0 & Expected wave height 0.5~1.0m	within 10 min
Tsunami Warning	ML ≥ 7.5 & Expected wave height over 1.0m	

# One-Stop Notification System



\* Earthquake flash in 2min.  
 \* Earthquake information in 5min.

→ Direct  
 → indirect





# Earthquake Info Alert App.



App. loading



Korea Earthquake Info



World Earthquake Info





# Earthquake Info Alert App.

제보 상세 페이지

진원 시간	2013-10-15 09:12:38	발생 위치	필리핀 타그빌라란 북동쪽 33km 지역		규모	7.2	
제보시간	2013-10-15 15:11:05	위도	10.2876	경도	124.0	제보 번호	2/2

진도

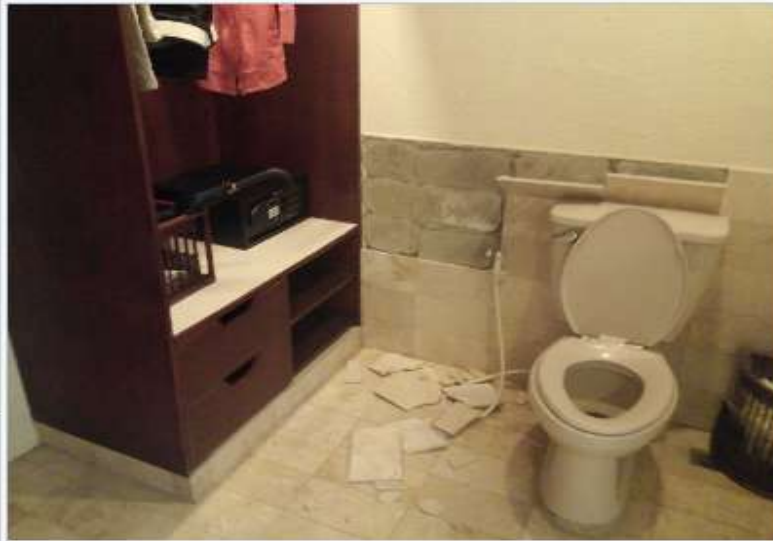
8

선택 내용

일반 건축물에 부분적인 붕괴 등 상당한 피해가 발생

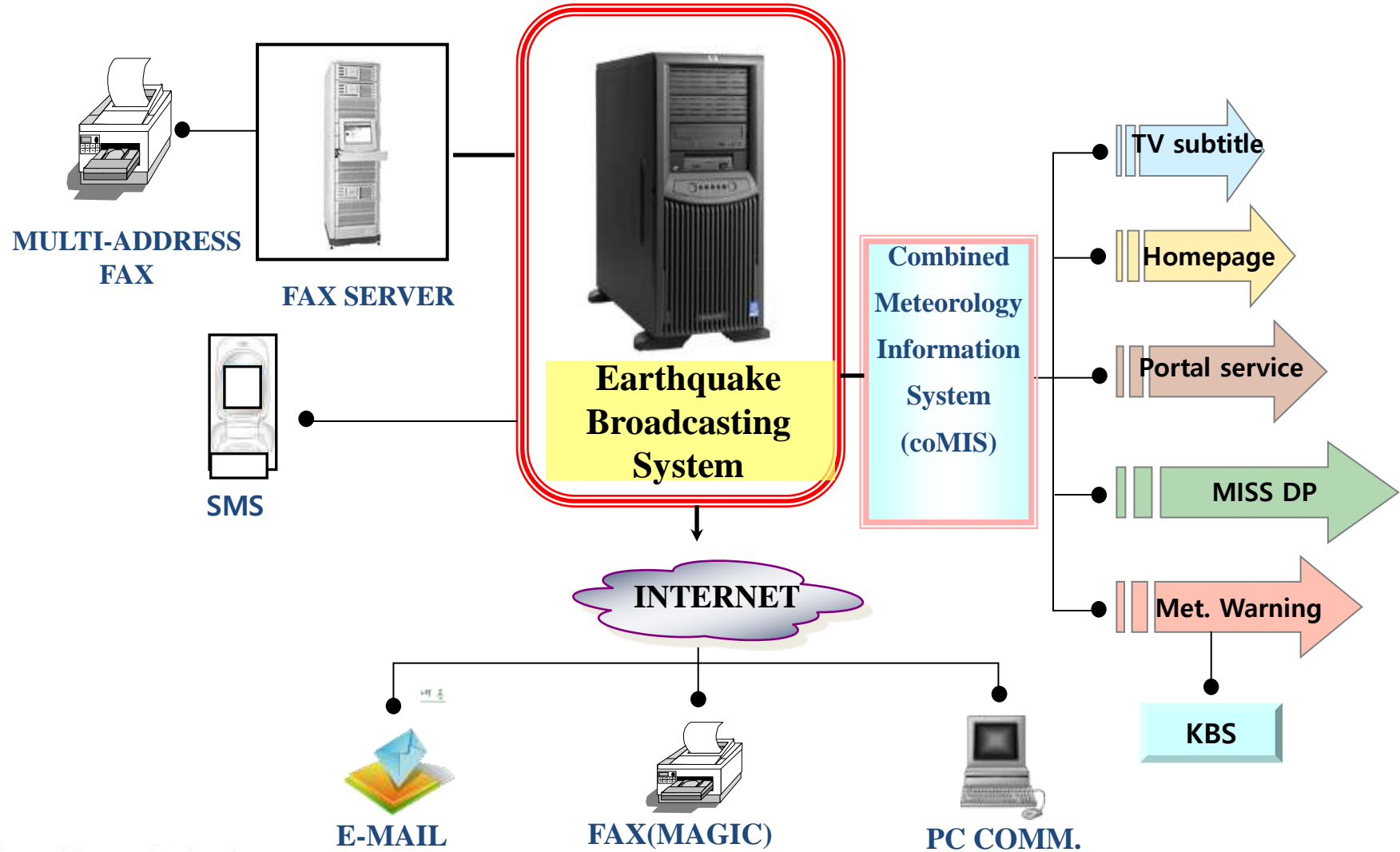
사용자 작성 의견

프린트





# Earthquake Broadcasting System



# National Earthquake Comprehensive Information System(NECIS)

**Observation network**  
Device, Location, History etc.,

**Earthquake data**  
Earthquake event, Waveform download

**Earthquake statistics**  
Earthquake occurrence year/area, search by scale

**Geophysical observation data**

“All about seismic and geophysical data”



<http://necis.kma.go.kr>



**Earthquake-related institution**



**Academic research**



**Industry**

**Data collection**

**Observatory**

Station	Channel
001	0010 0011 0012 0013 0014 0015
002	0020 0021 0022 0023
003	0030 0031 0032
004	0040 0041 0042 0043 0044

**Chart Data**

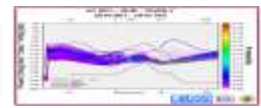
Station	Channel	Sample Channels	Starting Date	Ending Date
001	0010	0010 0011 0012	2009.05.01	2011.01.01
002	0020	0020 0021 0022	2009.04.01	2011.01.01
003	0030	0030 0031 0032	2011.01.01	2011.01.01
004	0040	0040 0041 0042 0043 0044	2011.01.01	2011.01.01

**Plot Data**



**Data analysis**

**Explore Data**



**View Report**

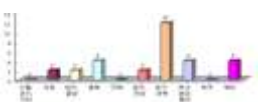
Station	Channel	Sample Channels	Starting Date	Ending Date
001	0010	0010 0011 0012	2009.05.01	2011.01.01

**Statistics**

**Filter Result**

Year	Count	Scale	Area
2009	10	2.0	100
2010	15	2.5	150
2011	20	3.0	200

**Statistics Report**



**Alert & Notify**





# KMA Seismological Network



Sensor type	Numbers
Very Broadband	1
Broadband	11
Broadband(Borehole)	32
Short-period	31
Accelerometer	56
Accelerometer(Borehole)	14



Broad-band



Short-period



Accelerometer



# Seismic Sensors in KMA

## Broadband



< STS-1 >



< STS-2 >



< STS-2.5 >



< CMG-3T >

## Short-period

## Accelerometer

## Borehole



< SS-1 >



< CMG-40T-1 >



< ES-T >



< CMG-3TB >



< ES-DH >



# Seismic Data Acquisition Systems in KMA

## Quanterra Inc.



< Q4120 >



< Q730 >



< Q330S >



< Q330HRS >



# KMA Broadband Station

Station ID : DGY2





# KMA Short-period Station

Station ID : DEI







# KMA Accelerometer Station

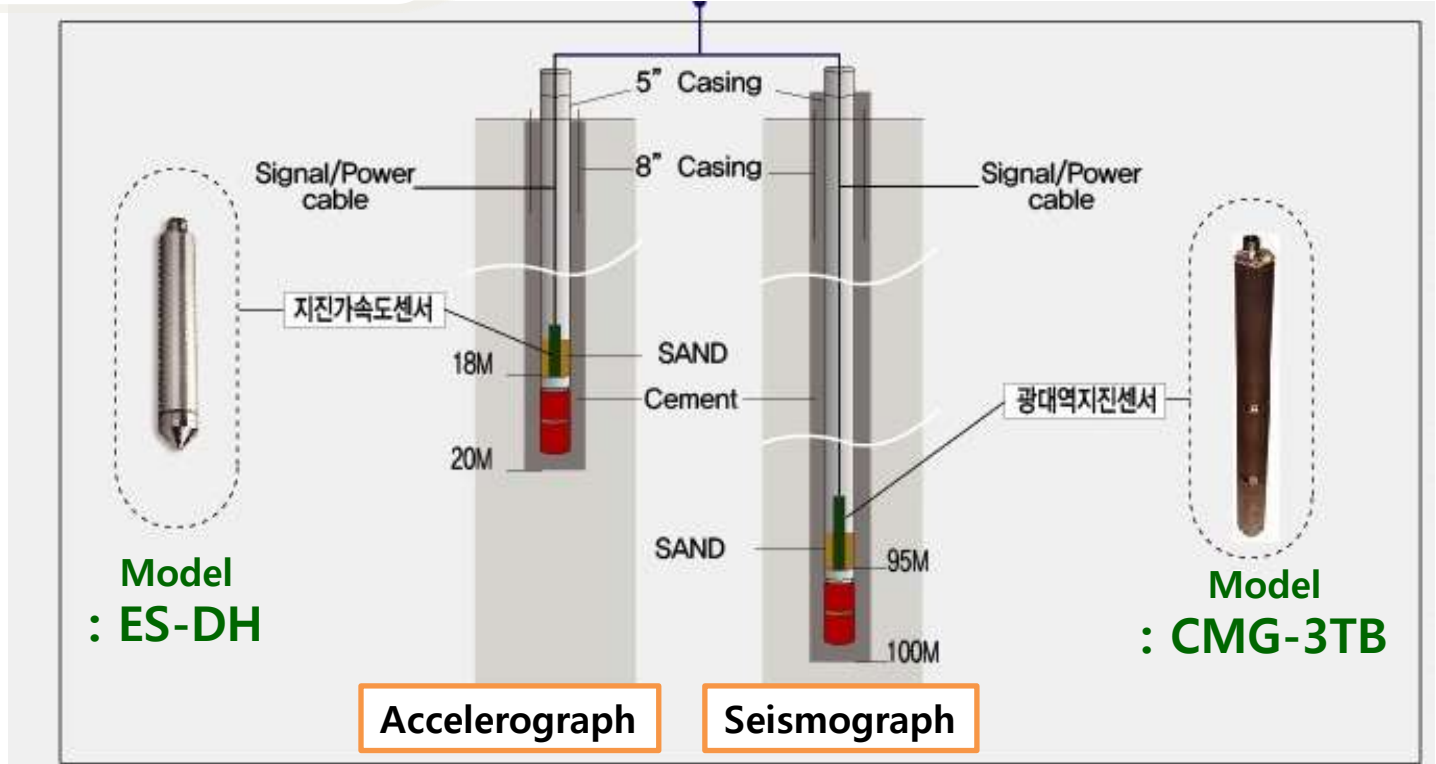
Station ID : GUM





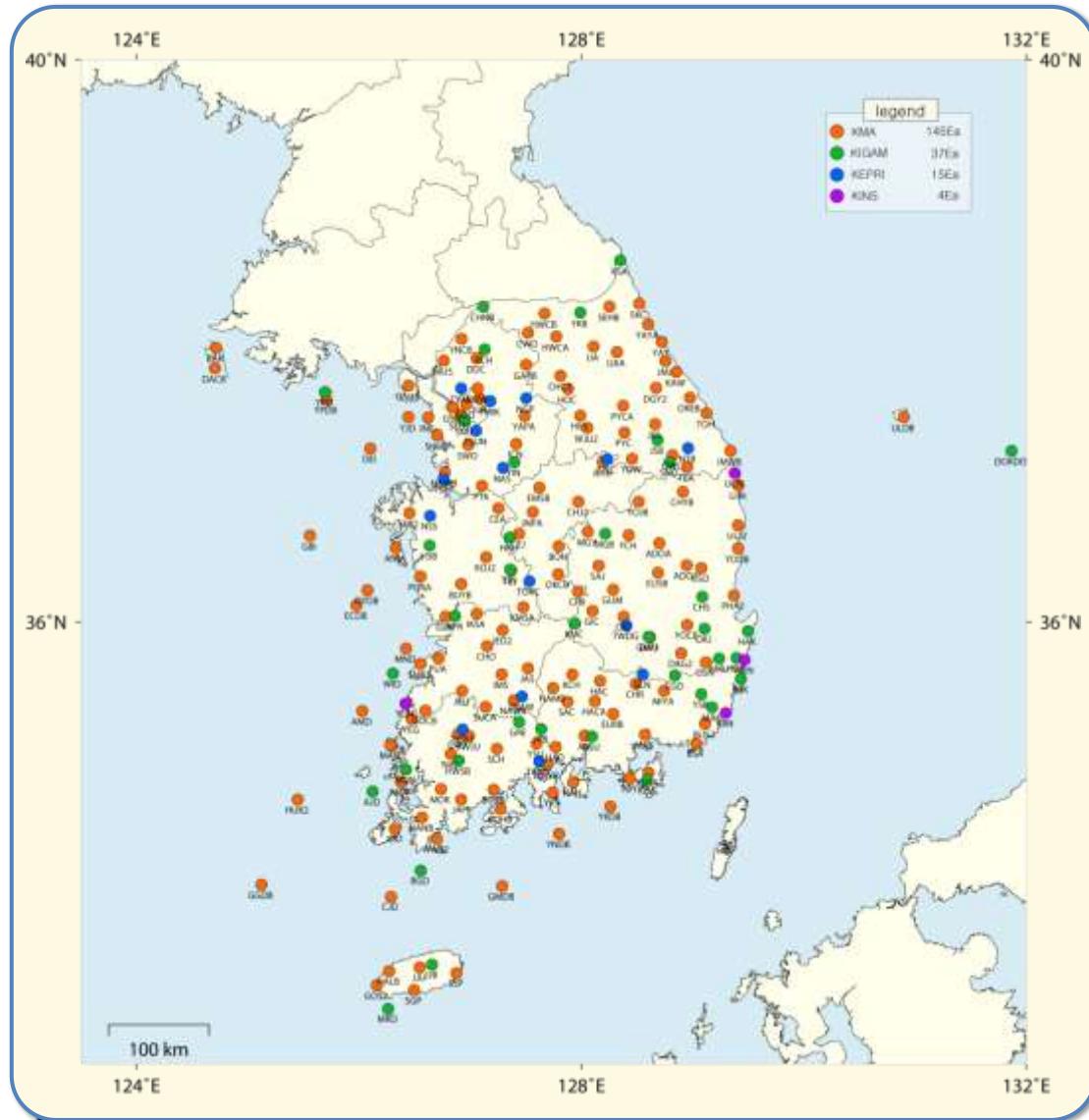
# KMA Borehole Station

**Station ID : GAHB**





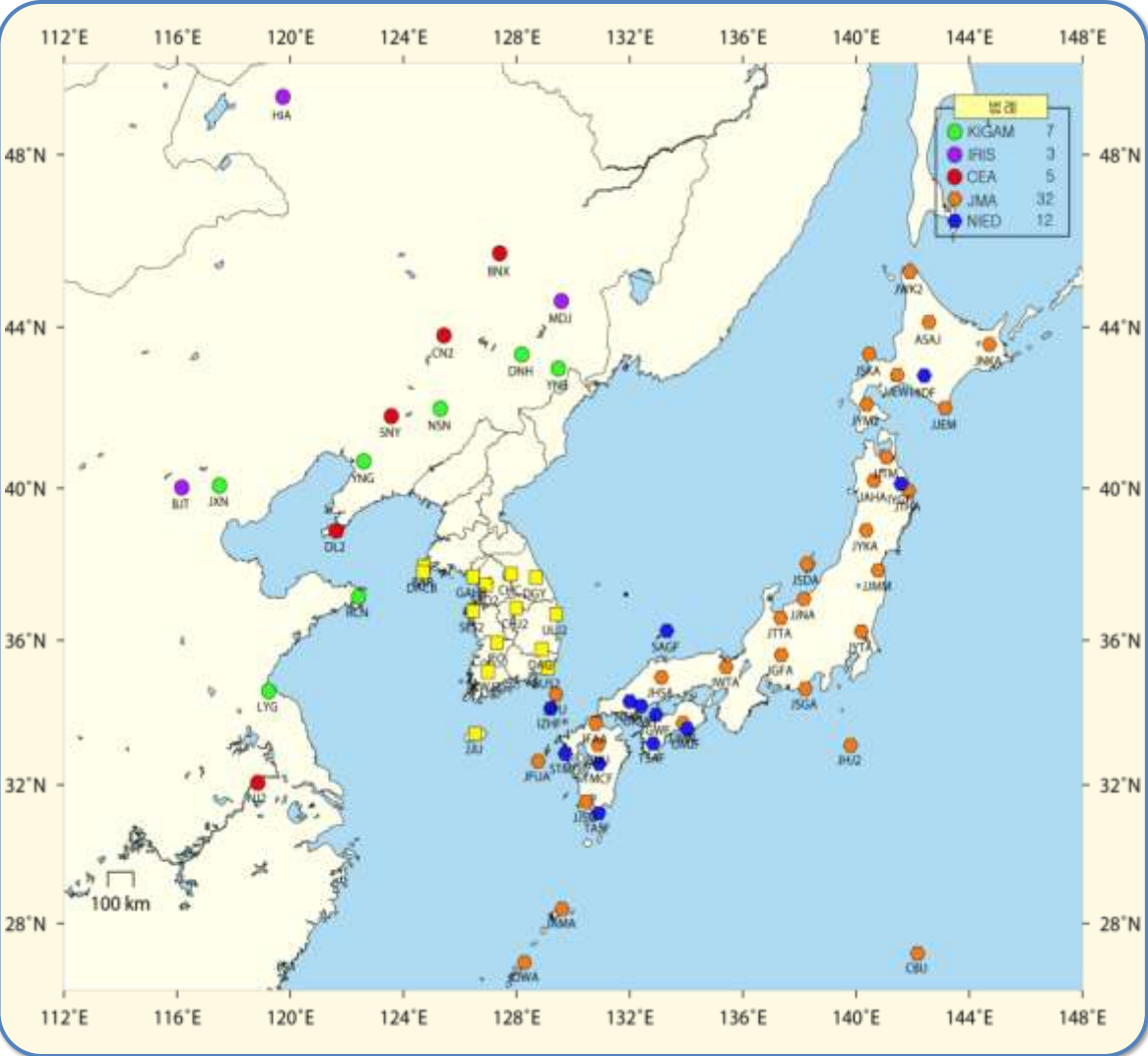
# Korea Integrated Seismic System



Institute	Stations
KMA	145
KIGAM	38
KEPRI	13
KINS	4

- \* **KMA** : Korea Meteorological Administration
- \* **KIGAM** : Korea Institute of Geoscience and Mineral Resources
- \* **KEPRI** : Korea Electric Power Research Institute
- \* **KINS** : Korea Institute of Nuclear Safety

# International Integrated Seismological Network



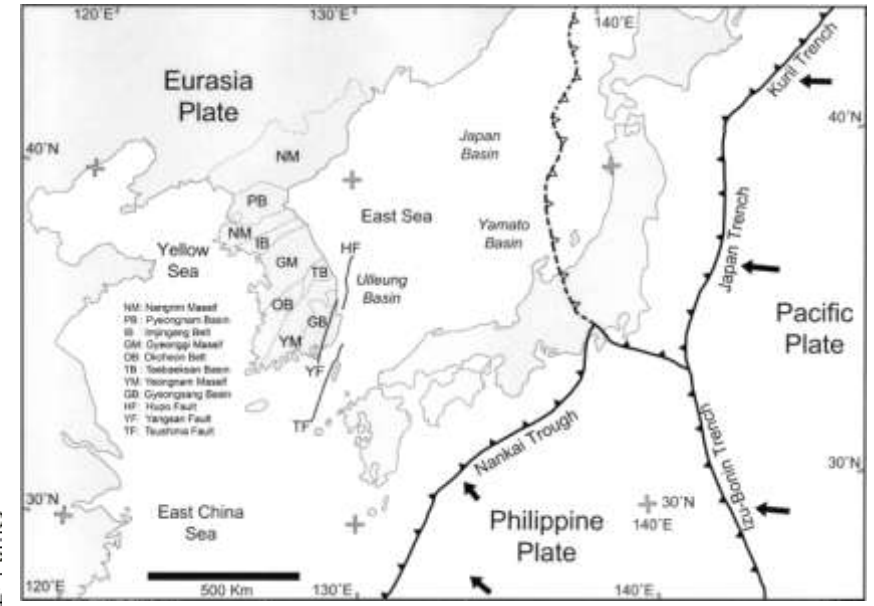
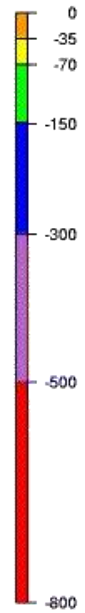
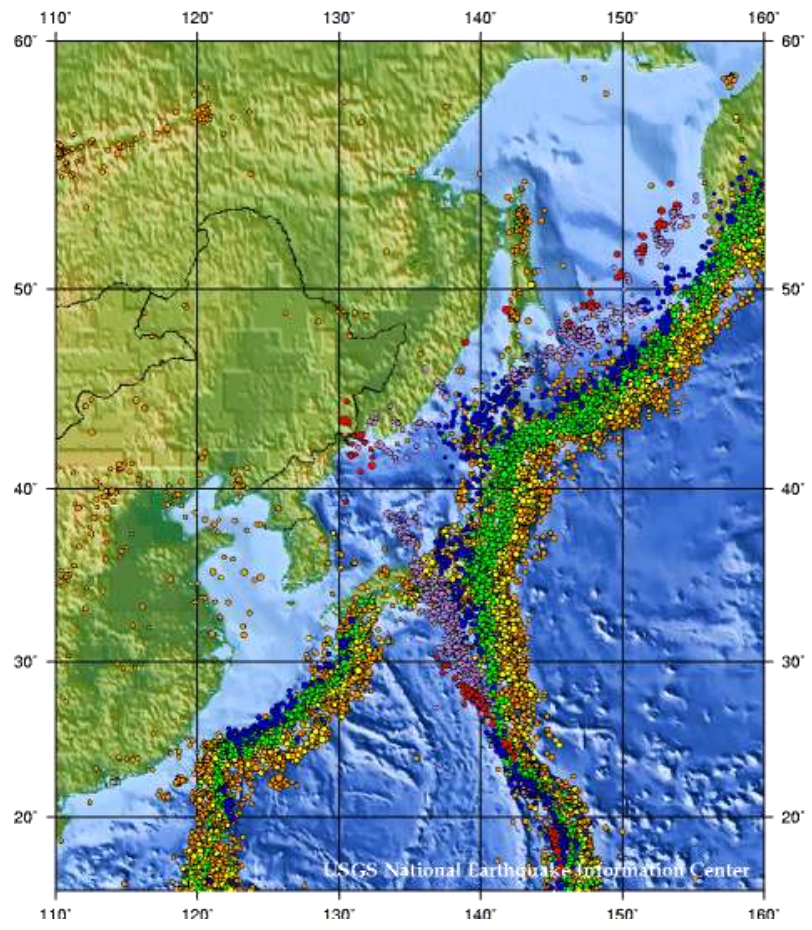
Country	Institute	Stations
Japan	JMA	22
	NIED	12
China	CEA	12
	IRIS	3

- \* **JMA** : Japan Meteorological Administration
- \* **NIED** : National Research Institute for Earth Science and Disaster Prevention in Japan
- \* **CEA** : China Earthquake Administration
- \* **IRIS** : Incorporated Research Institutions for Seismology



# Seismicity in Northeast Asia

From 1990 to 2010 by USGS

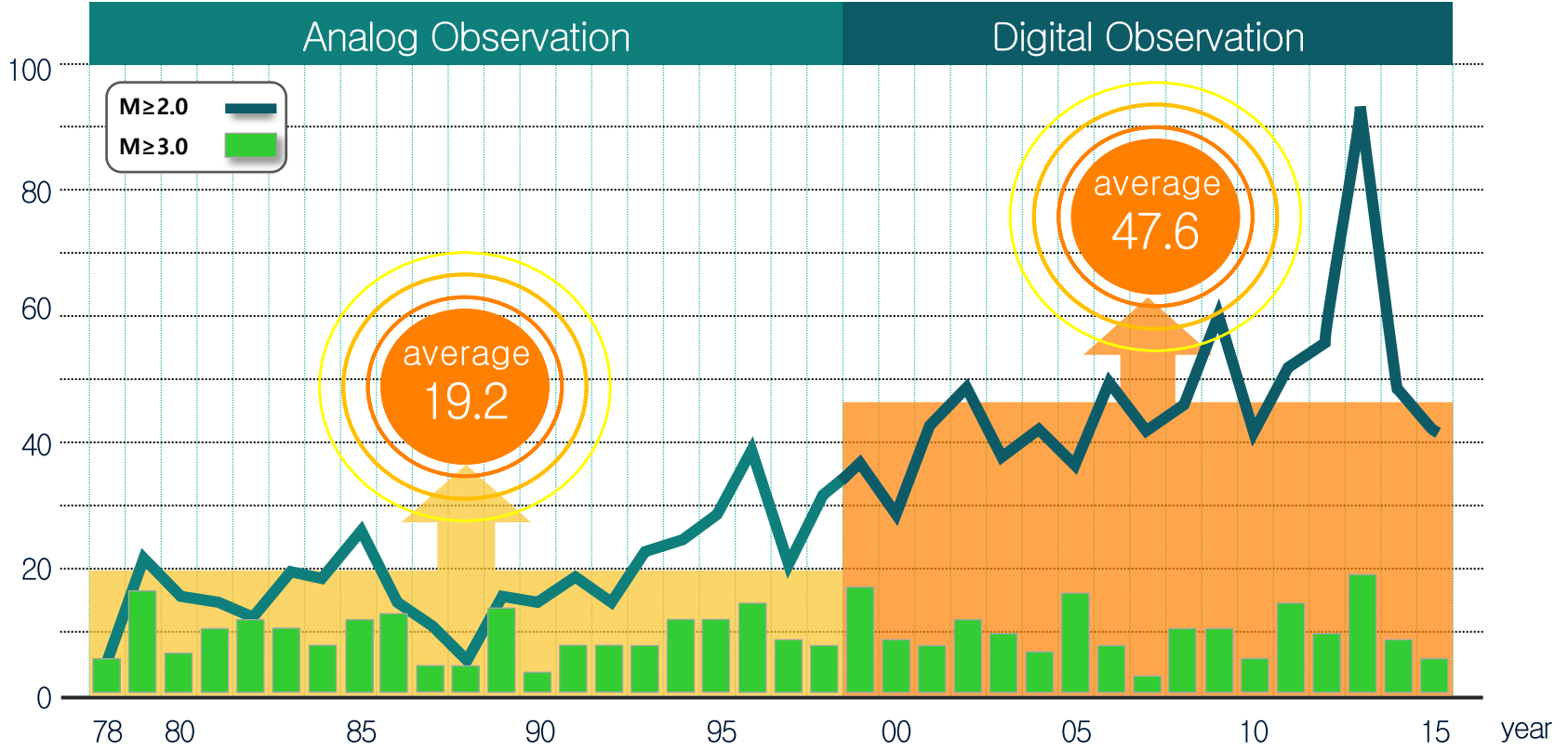




# Seismicity in Korea

## From 1978 to 2015

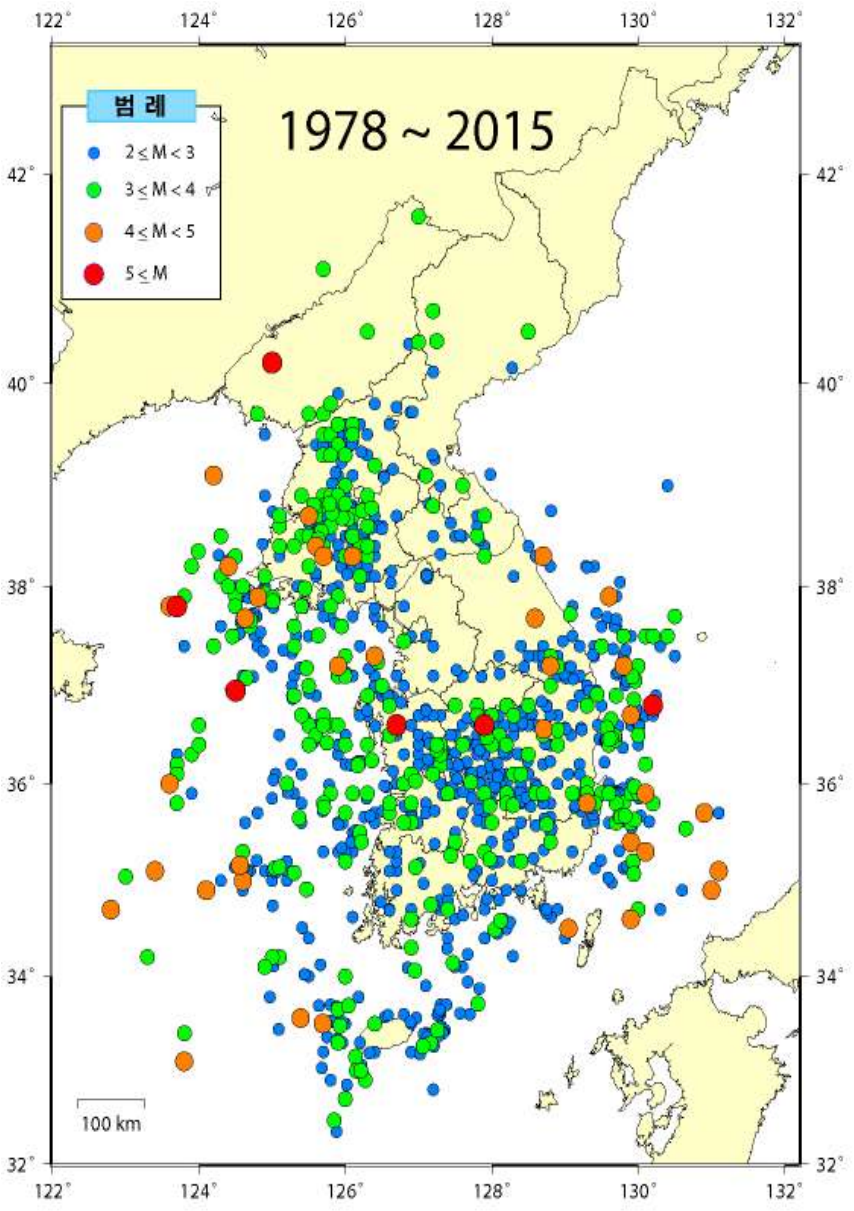
The number of earthquakes occurred



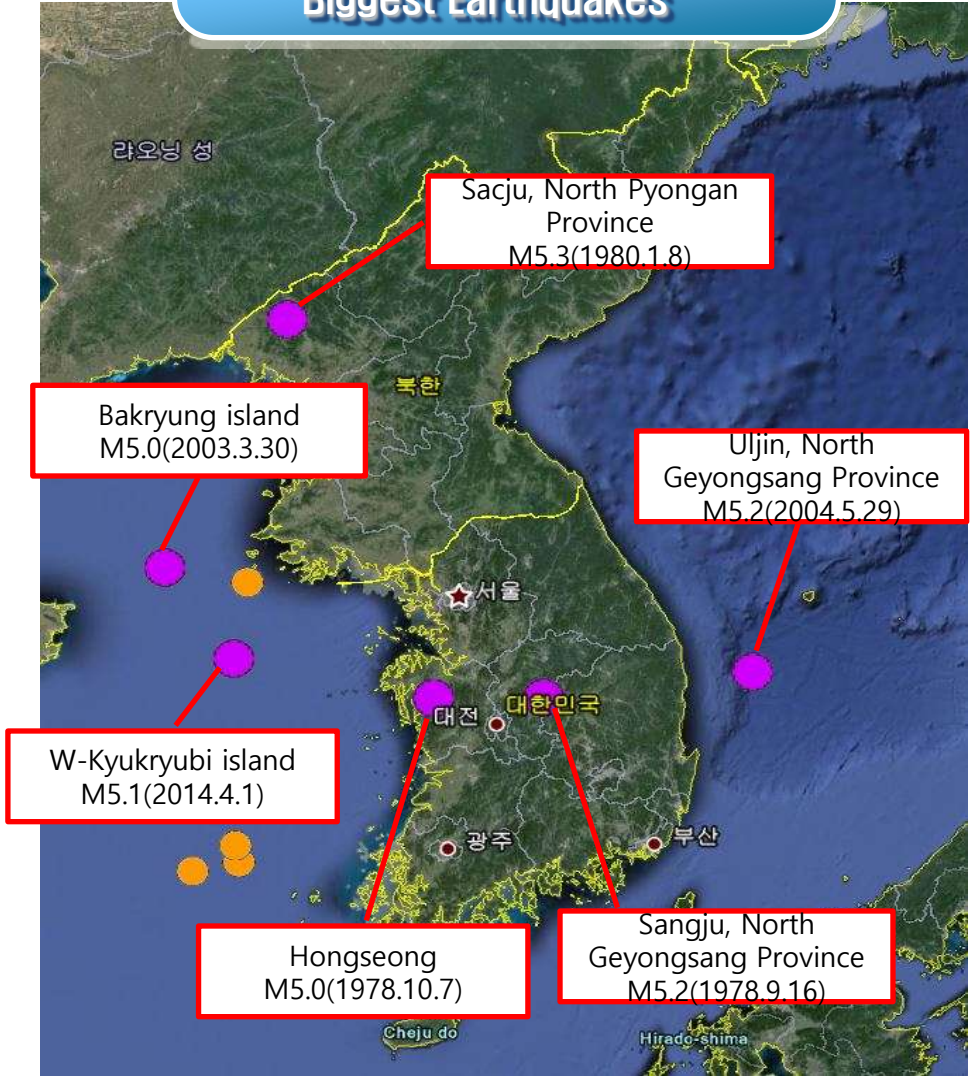
Occurrence	Annual Average	
	78~98(Analog Obs.)	99~15(Digital Obs.)
$M \geq 2.0$	19.2	47.6
$M \geq 3.0$	8.8	9.4



# Seismicity in Korea

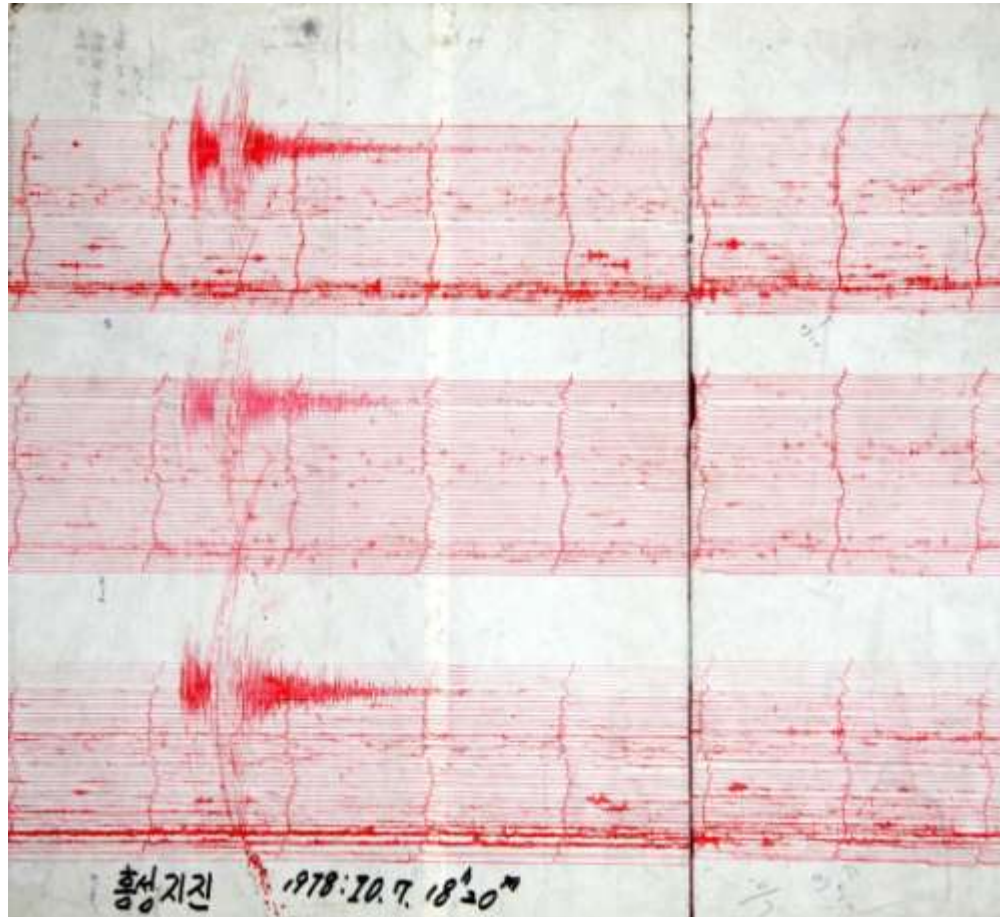


## Biggest Earthquakes





# Hongseong Earthquake



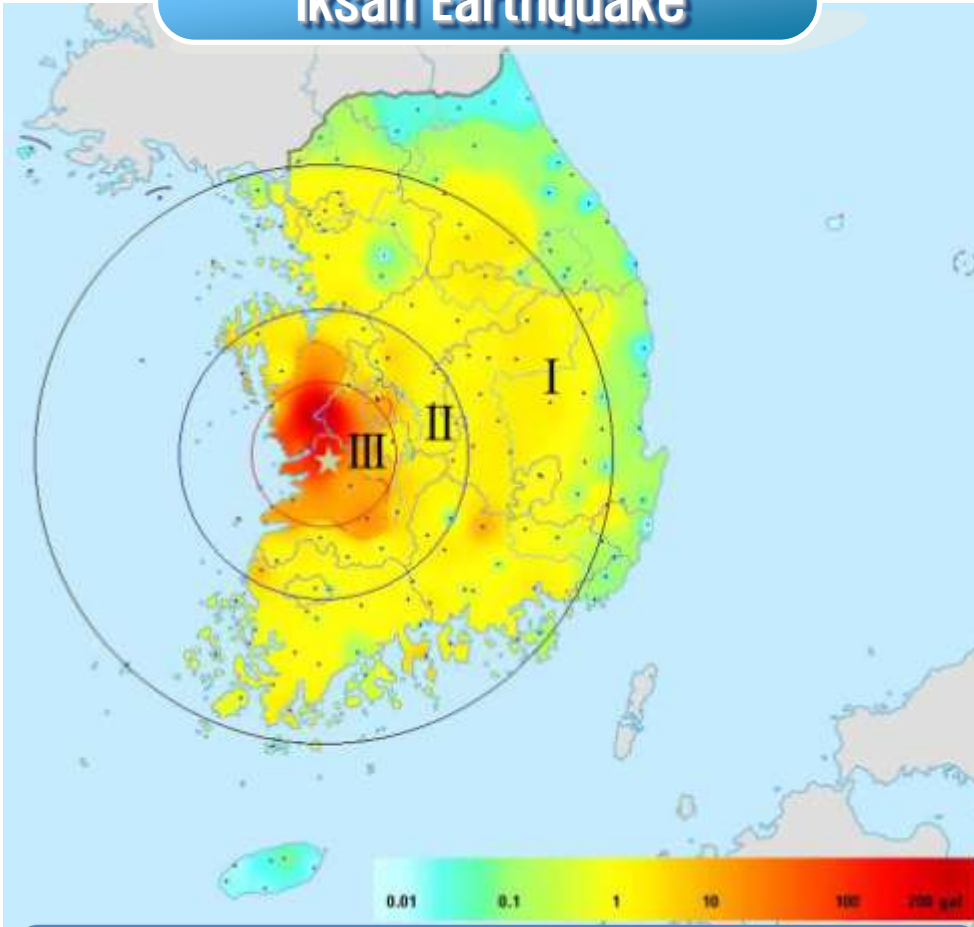
Korea Meteorological  
Administration



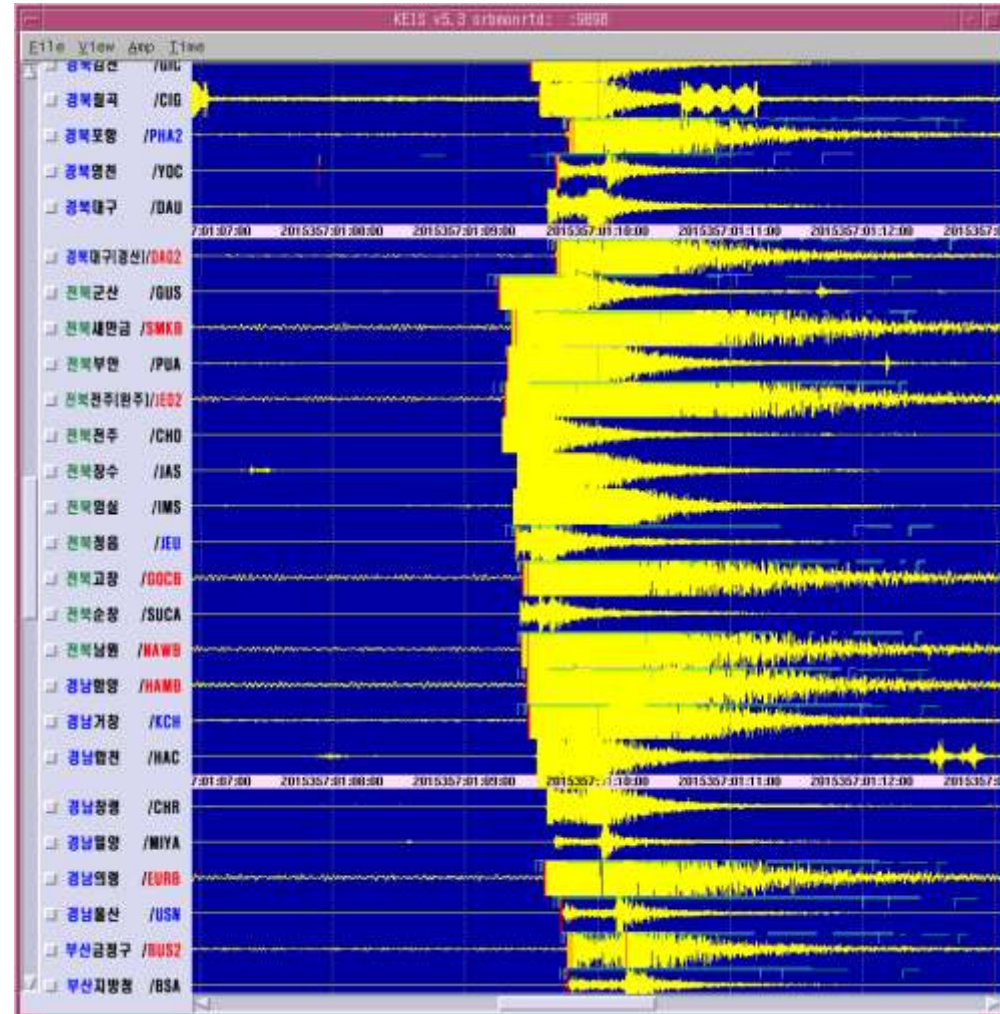


# Recent Earthquake in Korea

## Iksan Earthquake

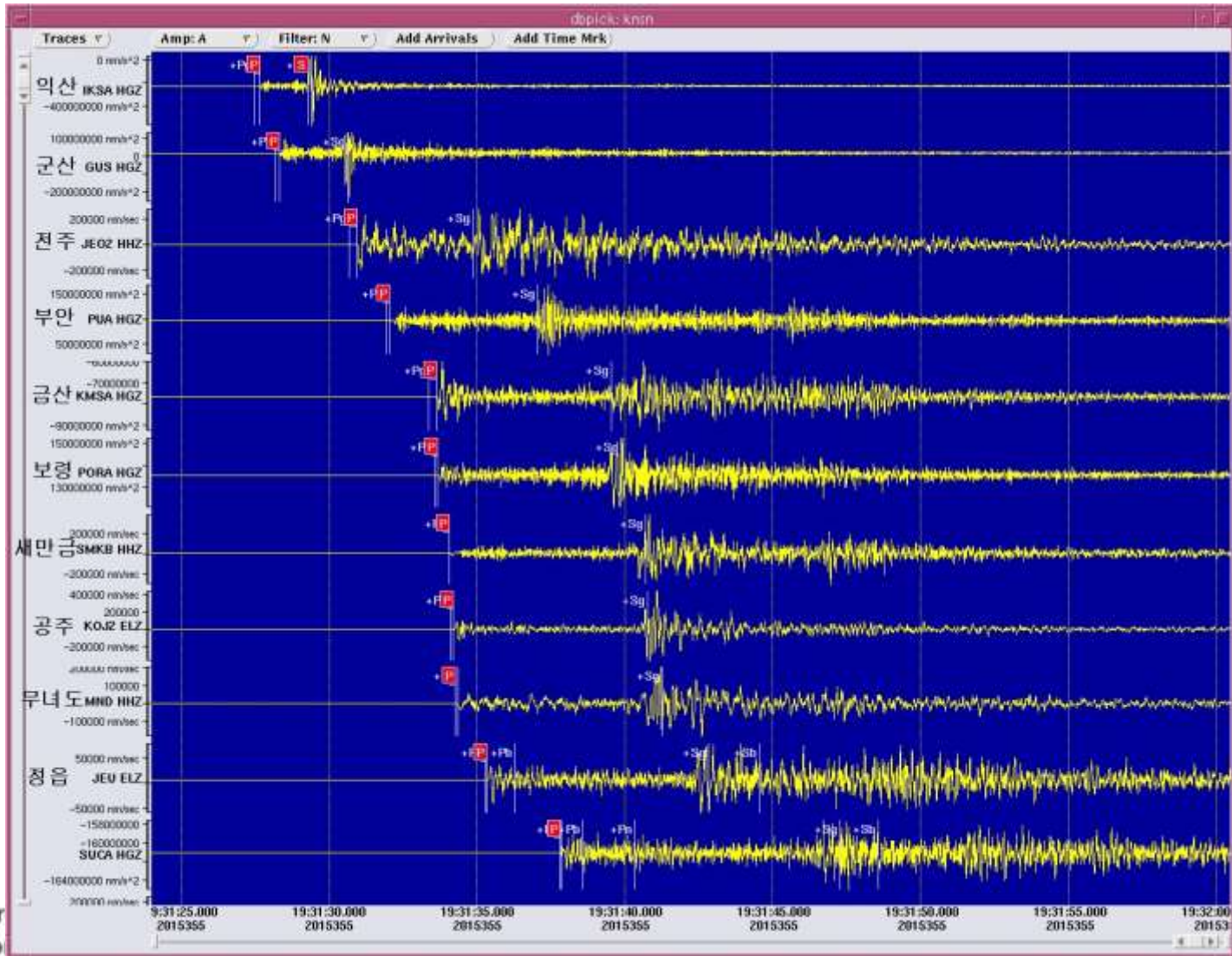


- Origin Time : 2015. 12. 22. 04:31:25
- Epicenter : 9km North of Jeonbuk Iksan
- Magnitude : 3.9
- Aftershocks : 3





## Event Picking





## Event Analysis

dbloc2

File View Help

11/03/2015 Next group from 12/21/2015 19:32:11.329 unassociated only 12/21/2015

Next Previous Regroup From first unassoc After last assoc Time-window 600 orid # Find

12/21/2015 (355) 19:31:28.207

GUS	0.137	19:31:24.500	19:31:25.500	19:31:26	19:31:26.500
BUYB	0.252				
JEO2	0.290				
PUR	0.348				
KMSA	0.437				
PORA	0.440				
SHKB	0.462				
KOJ2	0.475				
HND	0.479				
JEU	0.529				
SUCA	0.666				
NAWB	0.702				
GOCB	0.732				
OYDB	0.736				

order predicted

Select All Ignore All Ignore associated Mark associated Unmark Zoom out Original zoom Show Map with reporting stations

Origins:  Mark reviewed  Leave as-is  Mark NOT reviewed

orid	Keep	Prefor	Etype	evid	lat	lon	time	depth	dtype	sdobs	auth	nass	ndef	ml	mb	algorithm
1013	Keep	-	-	684	36.0228	126.9529	12/21/2015 (355) 19:31:24.79706	11.7893	f	0.1679	oalDbg	48	48			dbgenloc:iasp91
1014	Keep	-	-	684	36.0224	126.9511	12/21/2015 (355) 19:31:24.80475	10.1696	f	0.3769	oalDbg	91	86			dbgenloc:iasp91
1015	Keep	-	-	684	36.0256	126.9507	12/21/2015 (355) 19:31:24.81361	9.2372	f	0.3638	oalDbg	108	102			dbgenloc:iasp91
1017	Drop	-	-	684	36.0243	126.9503	12/21/2015 (355) 19:31:25.02713	11.0374	f	0.0219	KMA:rtM1	7	7	3.31		locsat:iasp91
1018	Drop	-	-	684	36.0232	126.9508	12/21/2015 (355) 19:31:25.00383	11.2935	f	0.0336	KMA:rtM1	8	8	3.40		locsat:iasp91
1020	Drop	-	-	684	36.0222	126.9503	12/21/2015 (355) 19:31:25.01287	11.3076	f	0.0314	KMA:rtM1	7	7	3.49		locsat:iasp91

Locate dblocsat2 iasp91 Starting location: Depth 9.2372  Fix Depth Maximum Iterations 40 View results

options Station Latitude 36.0256 Longitude 126.9507 View magnitude results

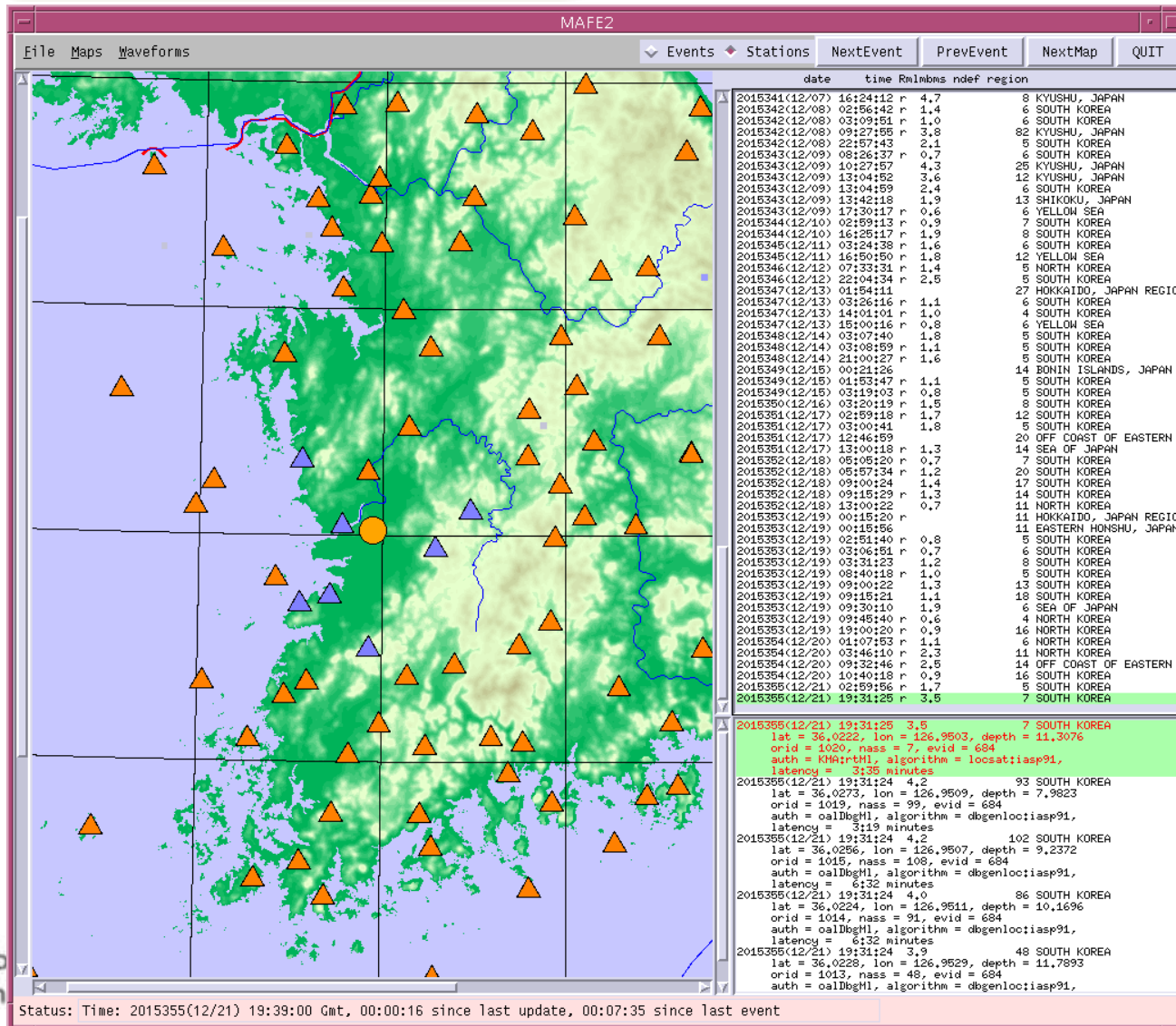
Waveforms  Arrivals  Detections  Predicted  Synchronize  Channels First # 1 40 Further Selected channels Show waveforms Hide waveforms

busy: rearranging arrivals to show residuals for 1020

Next Locate Associate Save Waveforms Map Database

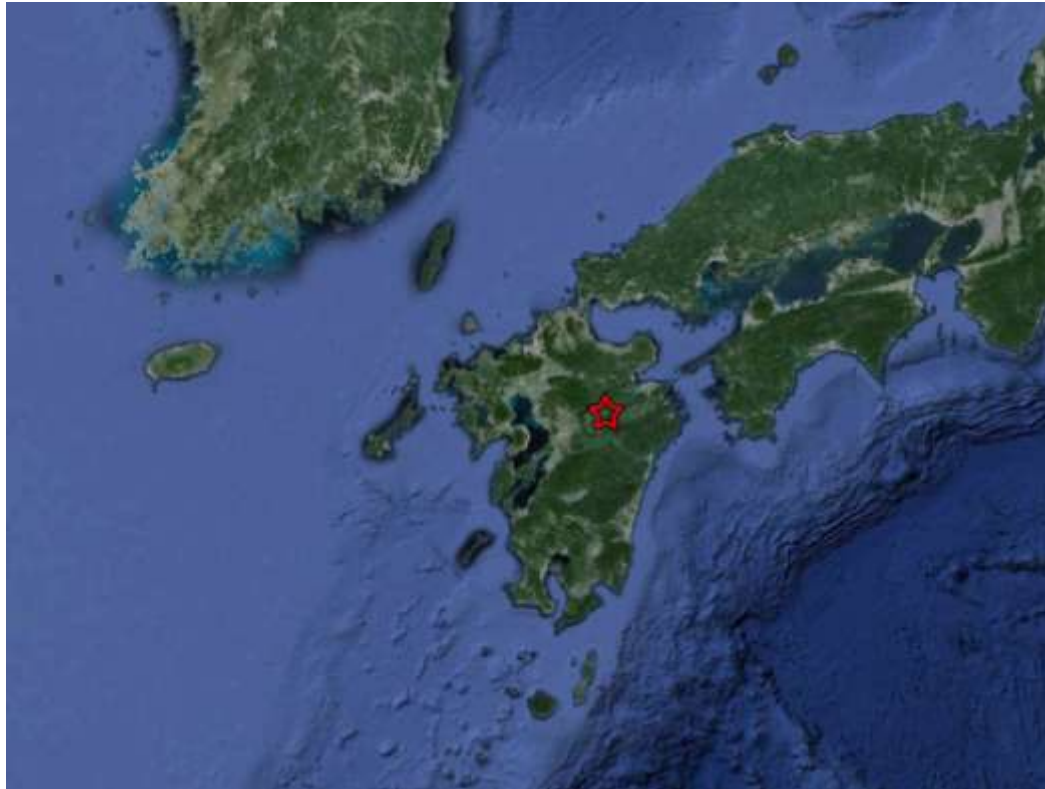


## Analysis Result

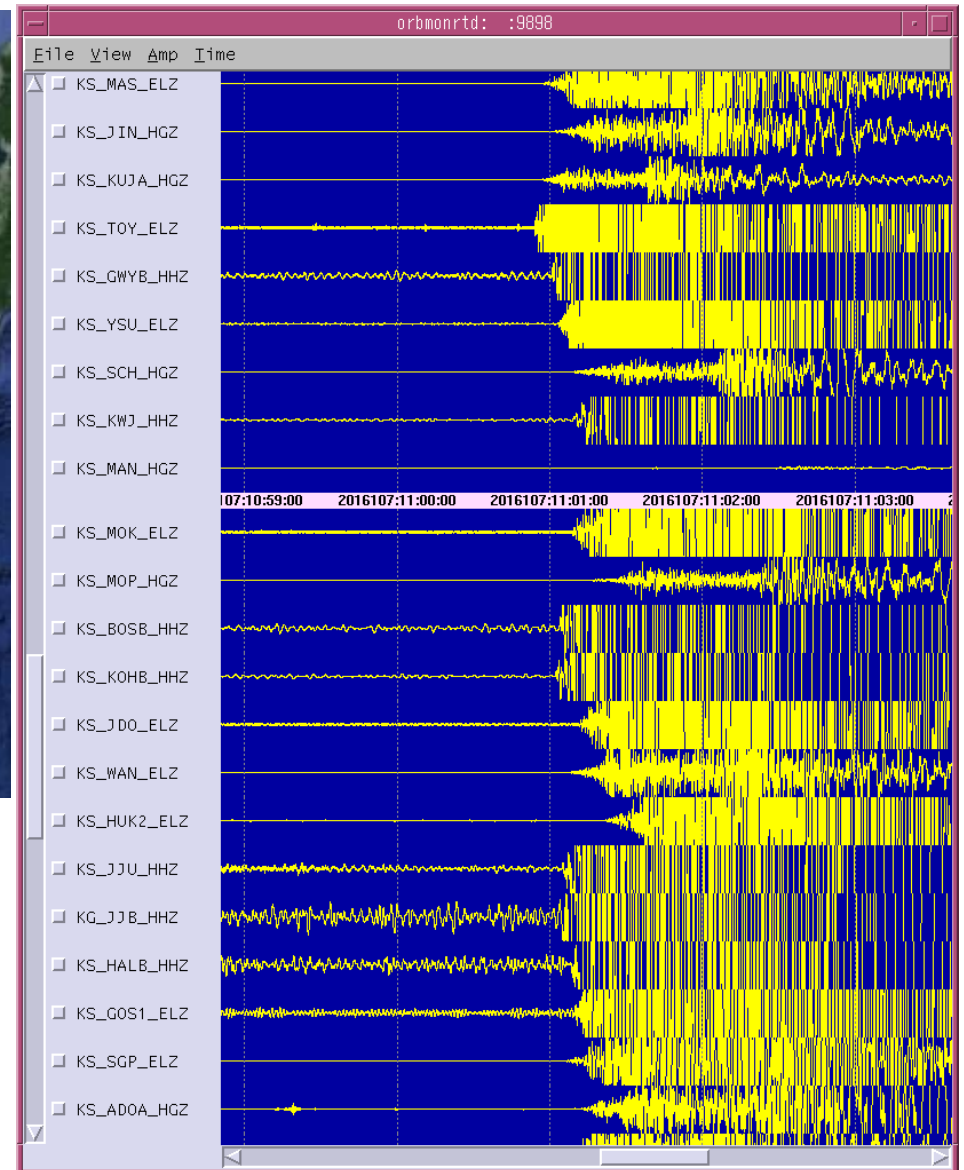




# Kumamoto Earthquake in Japan



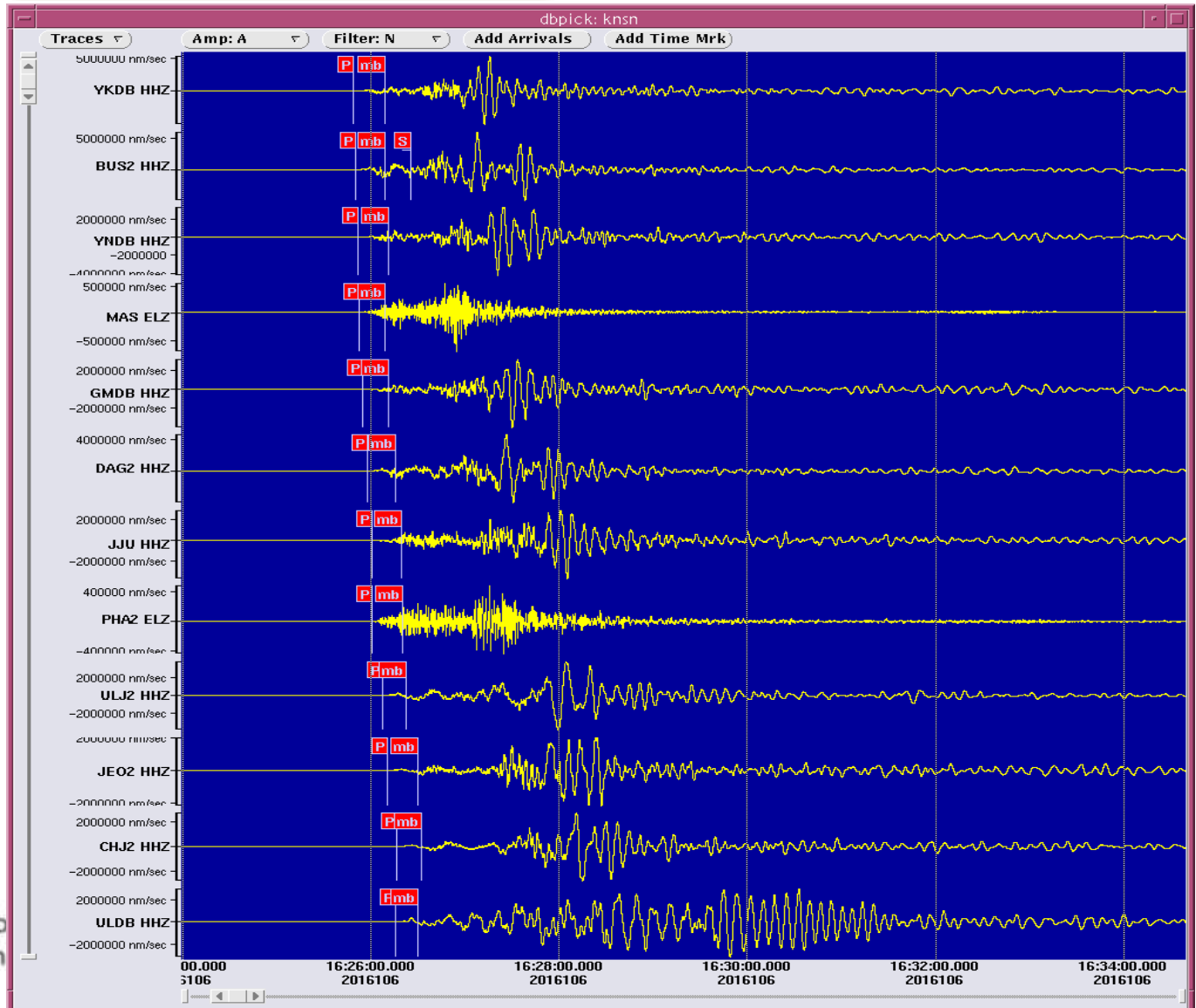
- **Origin Time : 2016. 4. 16. 01:25**
- **Epicenter : 9km East of Kumamoto**
- **Magnitude : 7.3**
- **Aftershocks : over 300(~2016.4.24)**





# Kumamoto Earthquake in Japan

## Event Picking





# Kumamoto Earthquake in Japan

## Event Analysis

dbloc2

File View Help

4/15/2016 Next group from 4/15/2016 16:25:50.955  unassociated only 5/15/2016

Next Previous Regroup From first unassoc After last assoc Time-window 600 orid # Find

4/15/2016 (106) 16:25:49.854

order predicted

Select All Ignore All Ignore associated Mark associated Unmark Zoom out Original zoom Show Map with reporting stations

Origins:  Mark reviewed  Leave as-is  Mark NOT reviewed

orid	Keep	Prefor	Etype	evid	lat	lon	time	depth	dtype	sdobs	auth	nass	ndef	ml	mb	algorithm
6	Drop		-	6	32.7804	130.7496	4/15/2016 (106) 16:25:03.71096	0.0000	f	1.7484	KMA:rtM1Mb	13	13	7.70	5.85	locsat:iasp91
7	Save		-	6	32.7813	130.7487	4/15/2016 (106) 16:25:04.17963	3.7772	f	0.3006	KMA:rtM1Mb	13	13	7.70	4.93	locsat:iasp91

Locate dblocsat2 iasp91 Starting location: Depth 10  Fix Depth Maximum Iterations 40 View results

options Station Latitude 35.2486 Longitude 129.1125 View magnitude results

Waveforms  Arrivals  Detections  Predicted  Synchronize Channels First # 1 40 Further Selected channels Show waveforms Hide waveforms

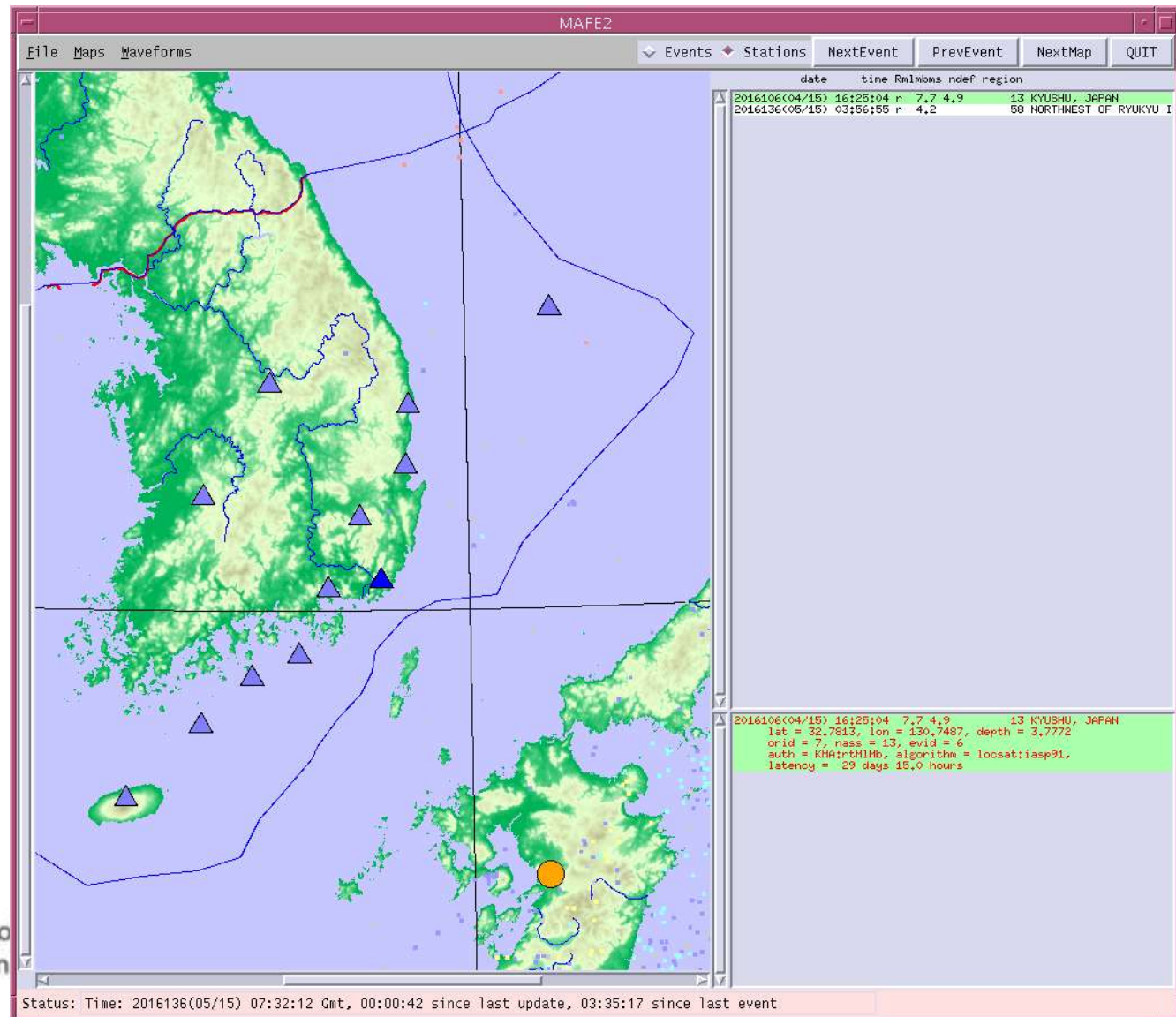
busy: rearranging arrivals to show residuals for 7

Next Locate Associate Save Waveforms Map Database



# Kumamoto Earthquake in Japan

## Analysis Result





# Tsunami Observation

- Real time monitoring of the long-period wave in the coast
  - through ultrasonic wave-height meter, wader gauge and CCTV



Observation system for coastal disaster prevention at 18 stations

46 tidal stations of KHOA

Sea surveillance CCTV at 24 stations

Ultrasonic wave gauge in Ulleung island





# Tsunami Damage



**☐ 1993 July 12 (M=7.8)**  
- Casualty : None  
- Ship Damage : 35

**☐ 1983 May 26 (M=7.7)**  
- Death : 1 Missing : 2  
- Ship Damage : 81



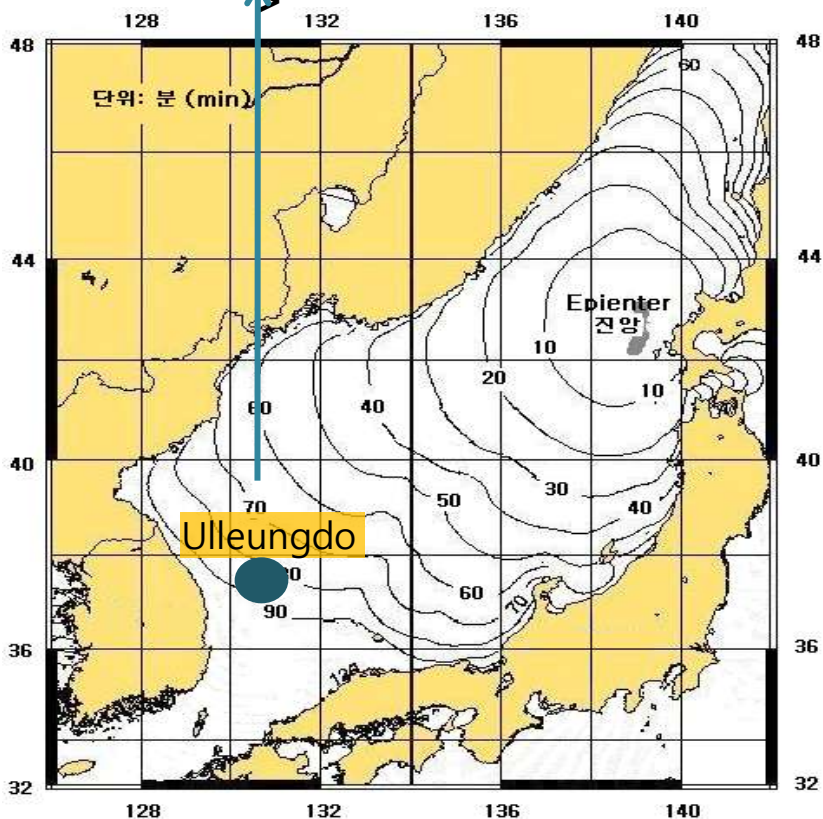
**Damage of Tsunami(Imwon port)**

# Tsunami Monitoring

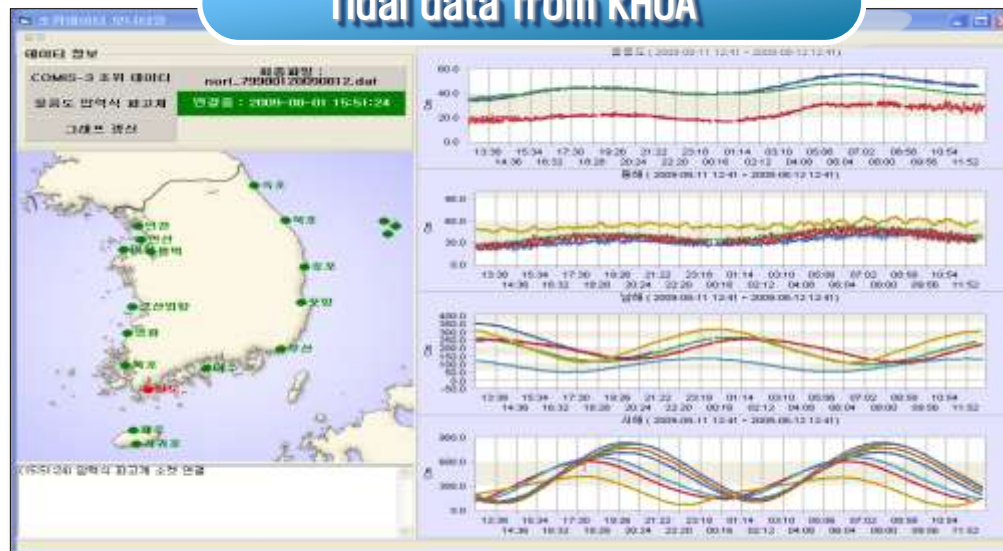


<Ulleungdo

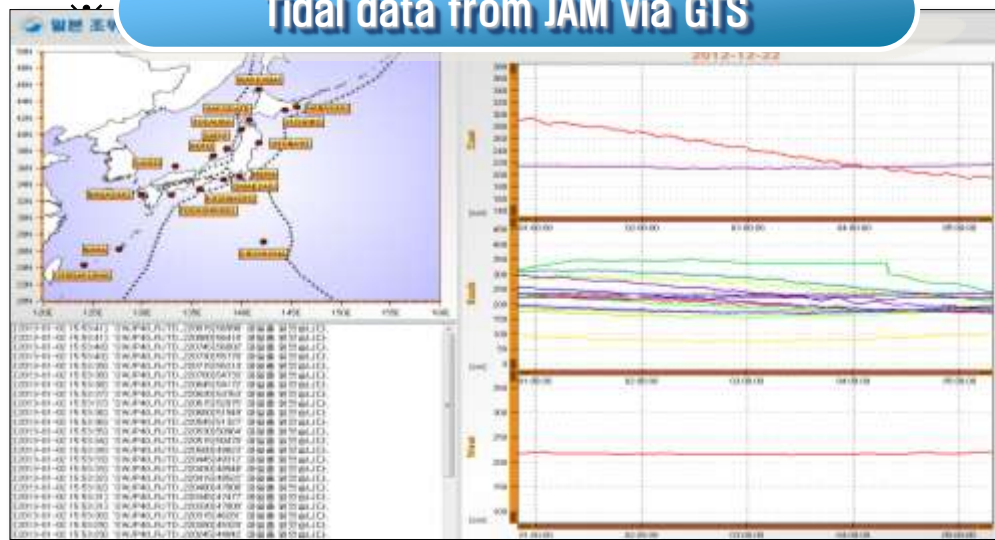
<Tsunami Gauge>



## Tidal data from KHOA



## Tidal data from JAM via GTS





# Tsunami Warning System

- Forecasting tsunami arrival and height of waves in 90 sea areas throughout the country
- Building up database of 6,000 epicenters with a magnitude range of 6 to 9 in the sea area around the Korean Peninsula

○ 기본지도 ● 지진해일 좌표 지도    목록변경    그래프 설정

**지진목록**

지진번호	진원시	위도	경도	규모	위치
2008290	2008-09-18 10:55:48	39.86	138.21	8.0	일본 혼슈 아키타 서쪽 ...
2008289	2008-09-12 14:33:32	0	0	0.0	테스트입니다.
2008288	2008-08-30 15:54:06	-6.19	147.26	6.3	파푸아뉴기니 라에 북...
2008286	2008-08-27 10:35:31	51.73	104.25	6.3	러시아 이르쿠츠크 서...
2008285	2008-08-27 06:00:37	-7.55	-74.47	6.3	페루 푸칼파 북쪽 93k...

**지진정보**

위도: 42.58    경도: 139.14    규모: 8.0    확인

진원시: 2008-10-08 15:19:21    현재 시각

위도: 42.55    경도: 139.15    거리(Km): 3.43    수심: 3235.5

**지점목록**

지점	지점명	소요시간	도달예상시각	파고
252	고성	01:35:36	2008-10-08 16:54:57	0.5 m
273	속초	01:36:42	2008-10-08 16:56:03	0.9 m
304	강릉	01:40:28	2008-10-08 16:59:49	1.3 m
323	삼척	01:42:14	2008-10-08 17:01:35	1.6 m
336	임원	01:45:58	2008-10-08 17:05:19	2.2 m
353	울진	01:48:37	2008-10-08 17:07:58	1.8 m
372	후포	01:54:07	2008-10-08 17:13:28	0.4 m
389	영덕	01:57:48	2008-10-08 17:17:09	0.3 m
408	포항	01:54:52	2008-10-08 17:14:13	0.7 m

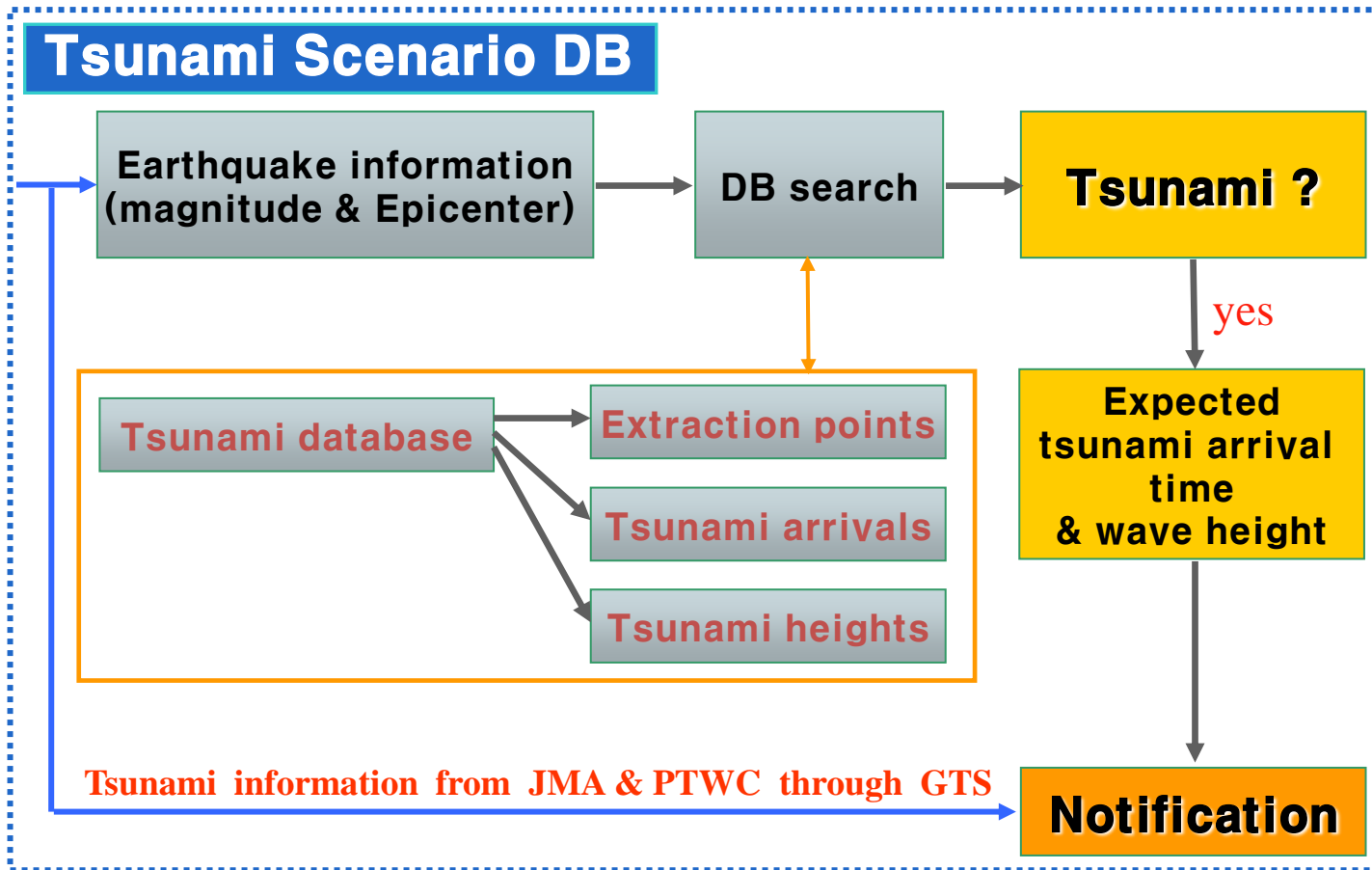
인쇄    결과 확인    그래프    해일경보    해일주의보

**정보**  
위 목록에서 원하는 지점을 클릭하시면 지점정보가 표시됩니다.

Ver2.0.3    42.58, 139.14    2008-10-08    오후 3:27



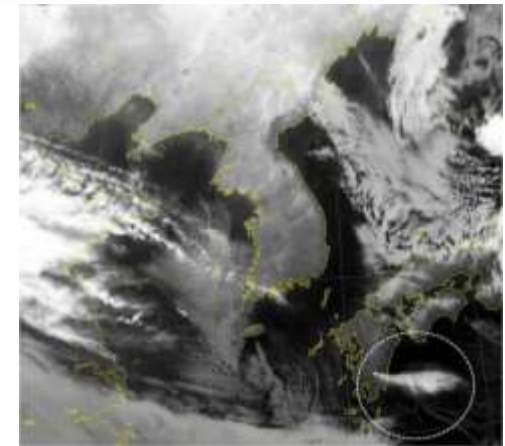
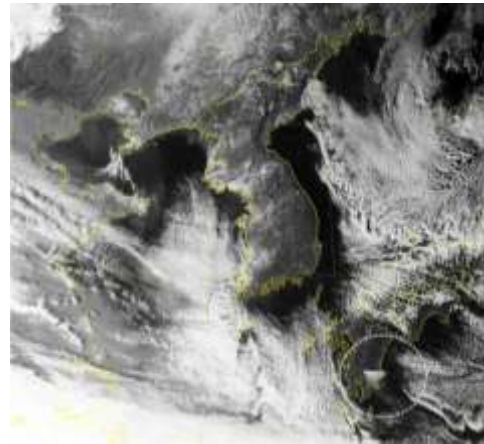
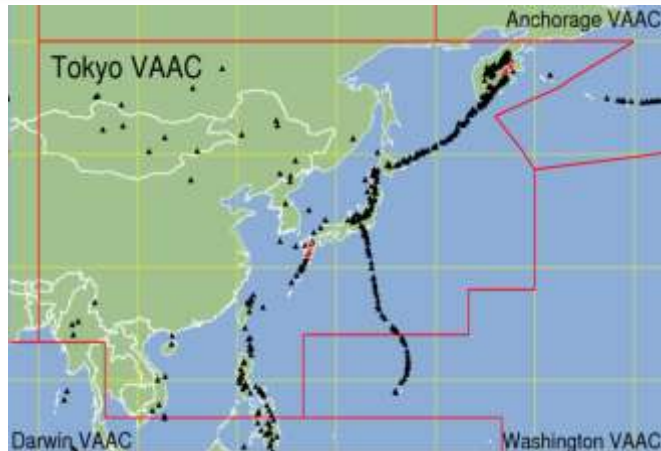
## Earthquake Broadcasting System





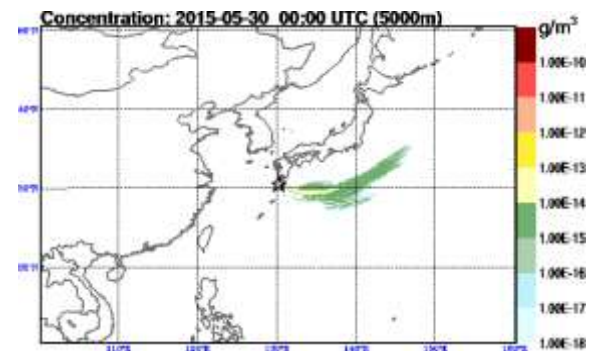
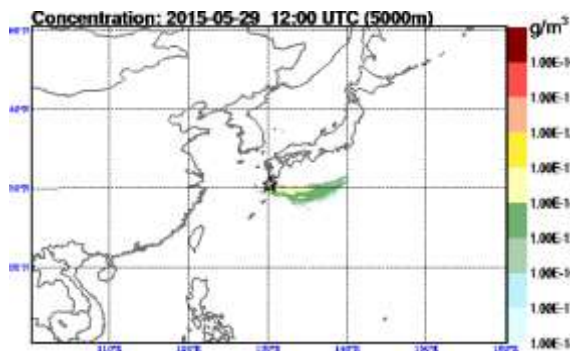
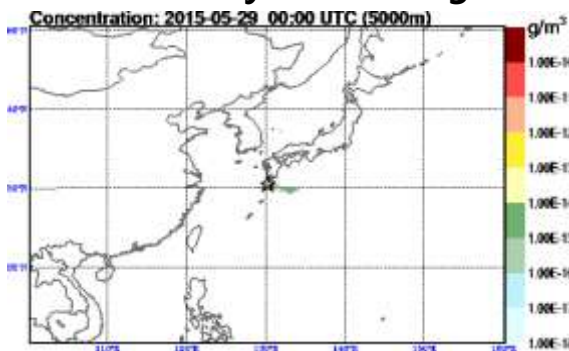
# Volcano Monitoring

- Monitoring volcanoes around Korea Peninsula by collecting Tokyo VAAC & KMA satellite data etc.
- Issue special report on volcanic ash using Volcanic Ash Dispersion Forecasting System



< Tokyo VAAC region >

< Satellite Image of Sinmoedake Volcano Eruption('11.1.26) >



< Volcanic Ash Dispersion Forecasting of Guchinoerabusima Volcano Eruption('15.5.29) >



# National Earthquake & Volcano Center



# Thank you.

