

SEISMIC RISK MONITORING & MANAGEMENT SYSTEM, ABU DHABI, UAE



The Sixth International Conference on “Seismology, Earthquake Engineering
and Antelope Users Group meeting” May 29-31, Baku, 2014



Ministry of Emergency Situations
of the Republic of Azerbaijan

Department of Earth Sciences of Azerbaijan
National Academy of Sciences

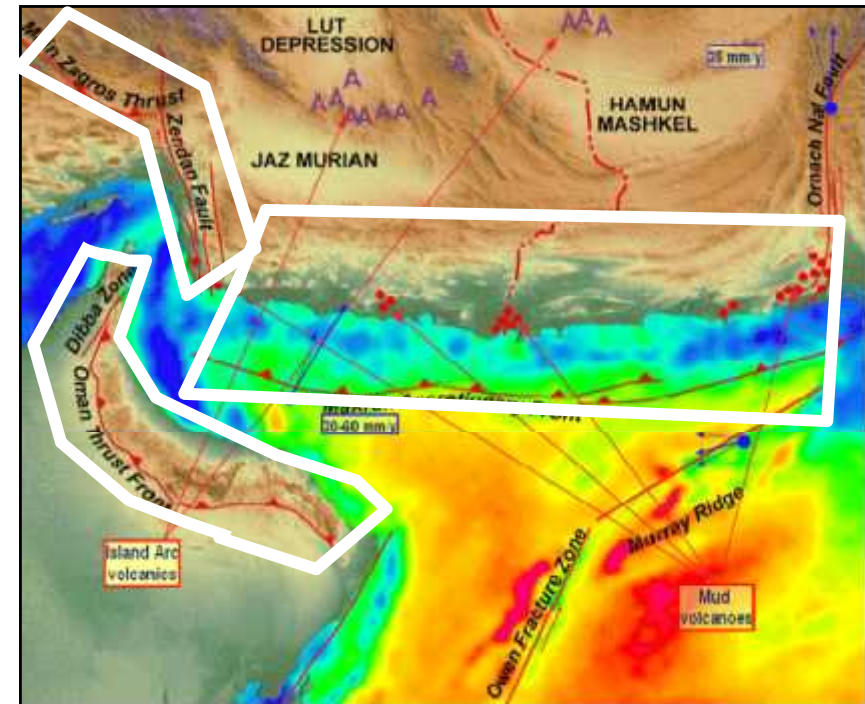
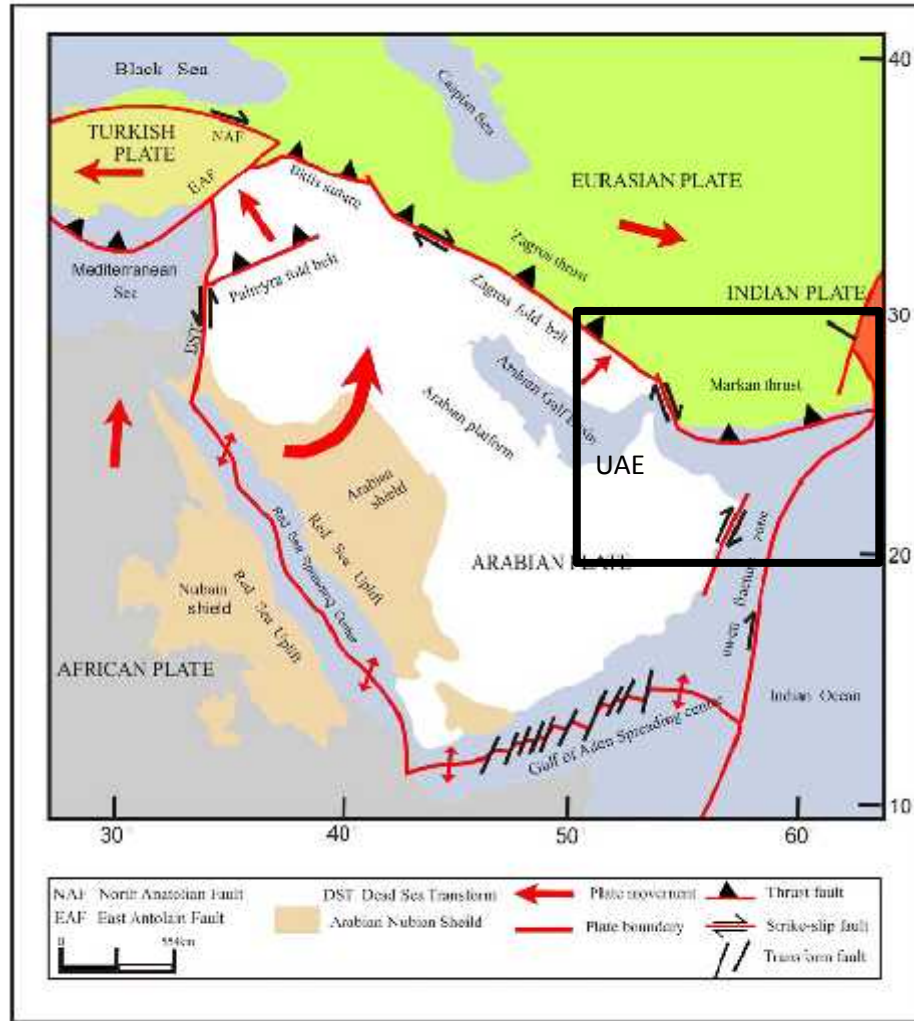


Outline

- Introduction
- Objectives
- Scope and project structure
- System Architecture
- Demo Emergency process



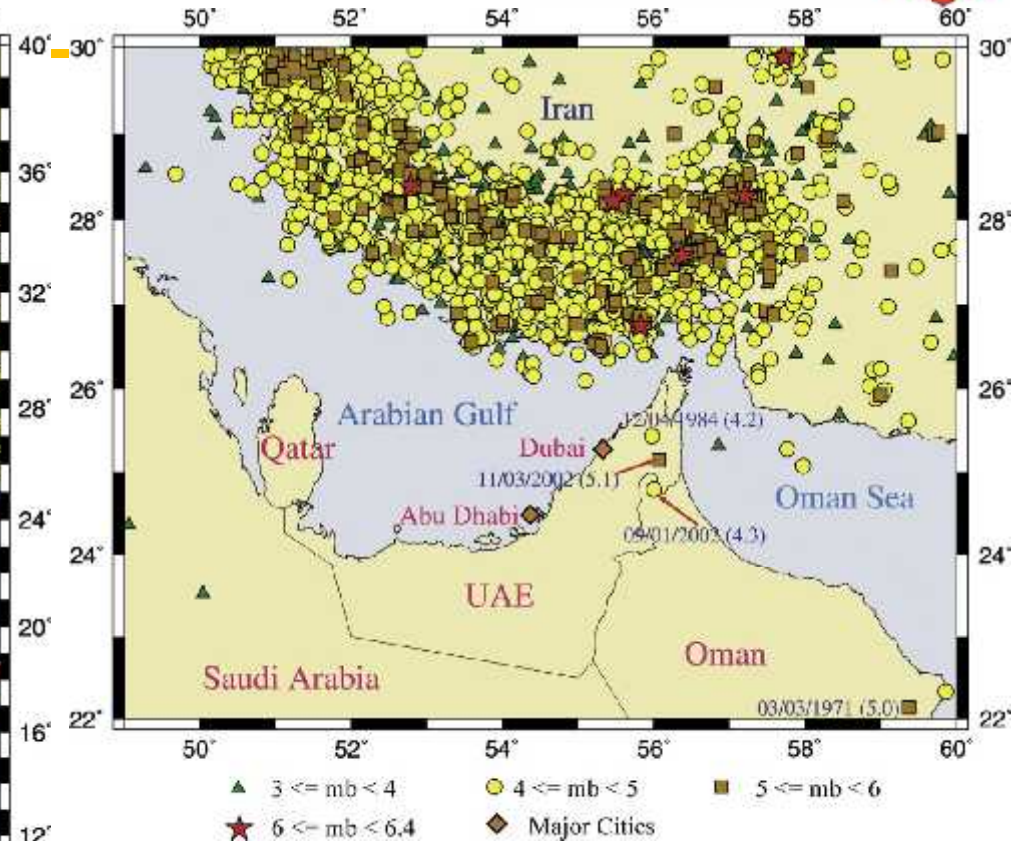
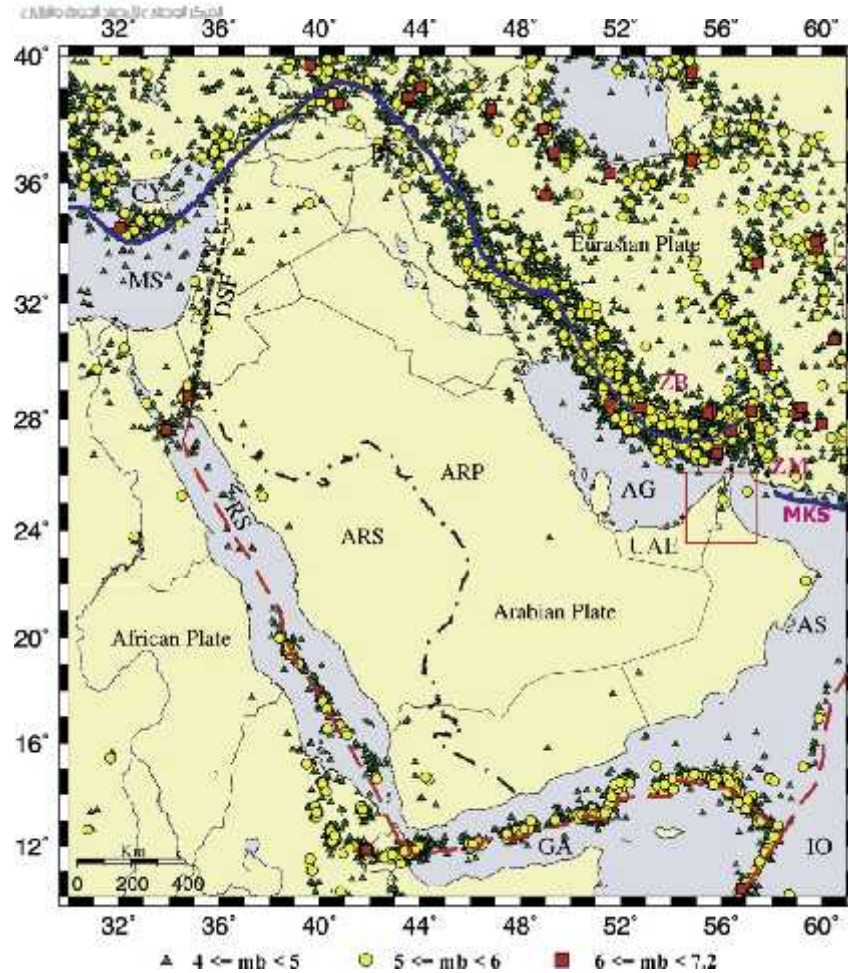
TECTONIC BOUNDARIES THAT CONTROL THE SEISMIC HAZARD IN UAE



The Makran Accretionary Prism and the Zone of Tectonic Subduction in the Northern Arabian Sea (Pararas - Carayannis, 2006)

Major tectonic elements surrounding the Arabian plate. (Bosworth et al., 2005).

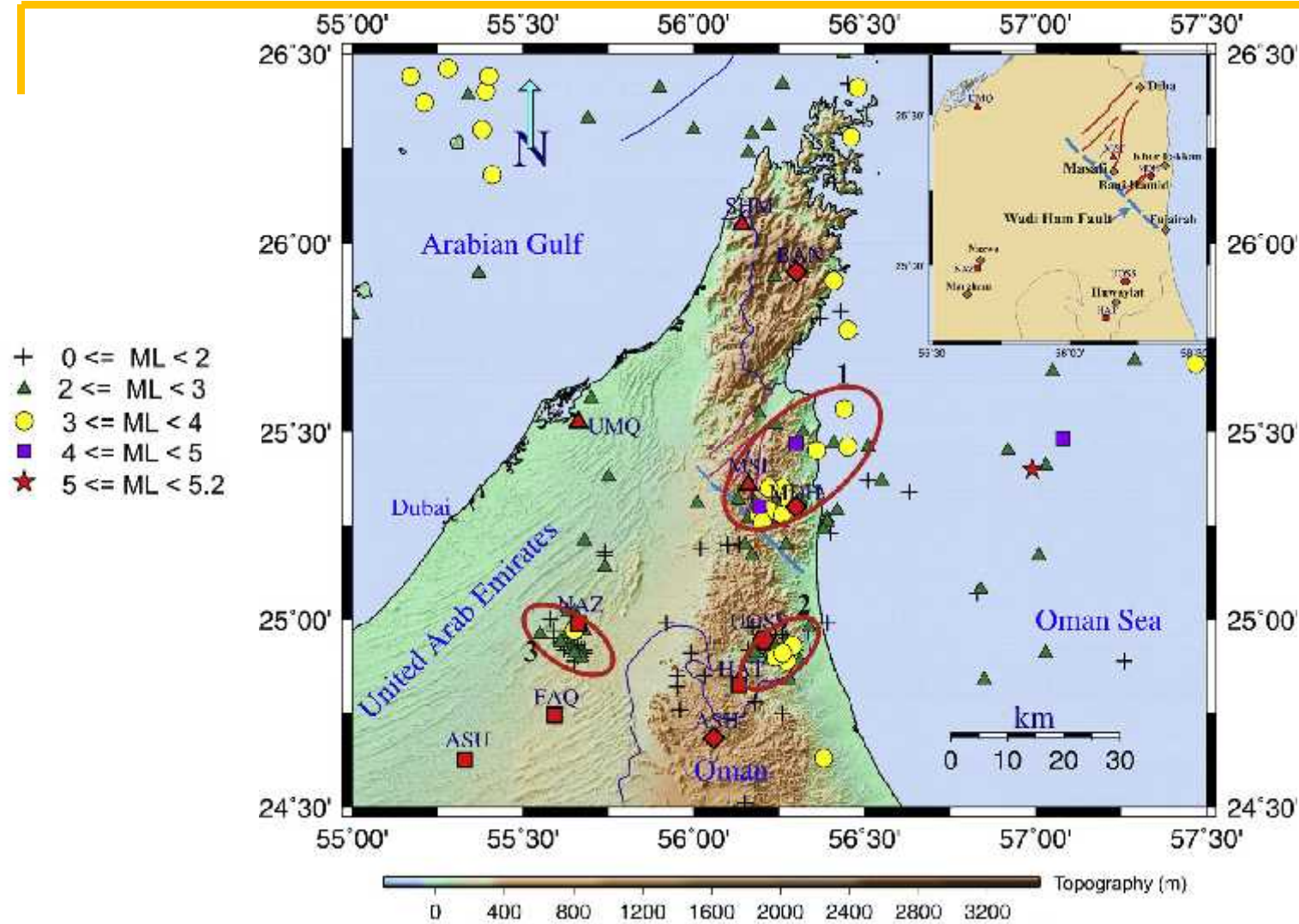




Observed seismicity of United Arab Emirates from 1964 to March 2006 (ISC data).

Tectonic boundaries of the Arabian plate.
Seismicity data was compiled from ISC (1964–2011) and NEIC (2012–July, 2013) for earthquakes with $mb \geq 4$.





Local seismic activity recorded by DSN from April 2006 to June 2013. Seismicity clusters



GENERAL OBJECTIVES



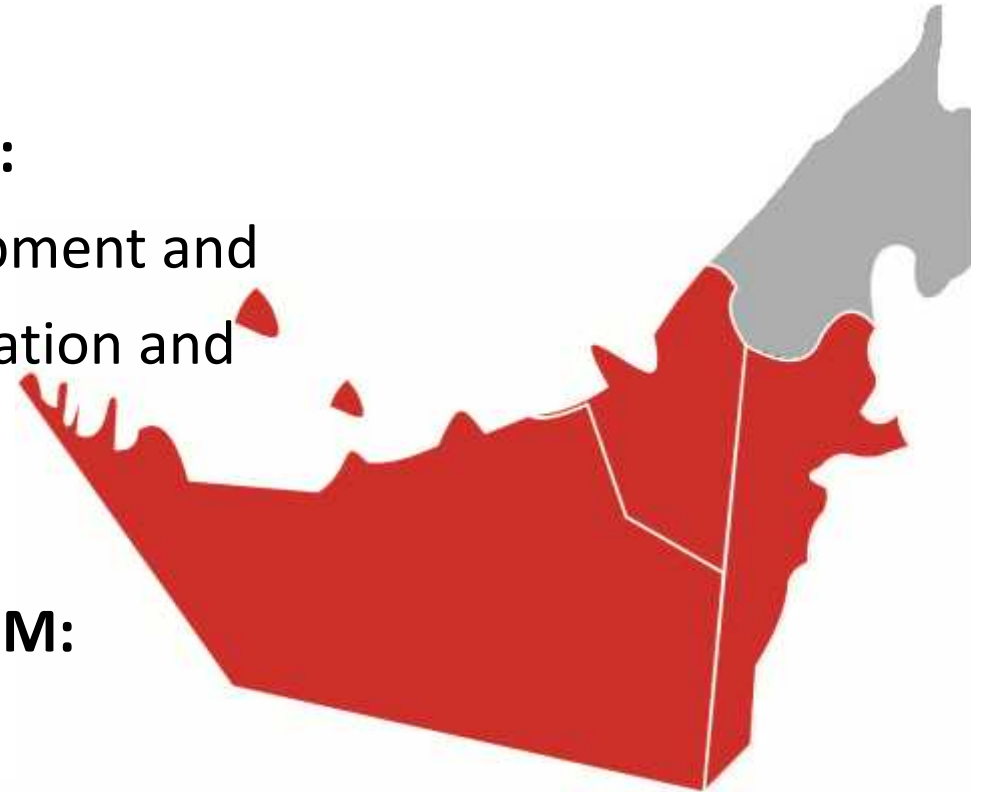
Responding to needs of the:

- Emirate of Abu Dhabi and National level in general, and,
- Municipalities in particular

in respect with seismic safety of:

- Current and planned development and
- Effective protection of population and material property

compliant with the vision of ADM:





To ensure a superior quality of life and a sustainable environment for Abu Dhabi residents



GENERAL OBJECTIVES

To design a system to meet national, municipal and community seismic safety goals by assuring consistent, technically sound and economically justified policies in the domain of:

- Prevention, Regional and Development Planning;
- Urban Planning and Land Development;
- Engineering and Development;
- Mitigation, Emergency Preparedness and Response; and,
- Promotion of Risk Prevention Culture and Public Safety.



SPECIFIC OBJECTIVES

- ❑ *Study: "Assessment of Seismic Hazard and Risk in Emirate of Abu Dhabi";*
- ❑ *System and associated data bases for: AD Seismic Risk Monitoring and Management System (AD-SRMMC-Centre);*
- ❑ Build National Capability; and,
- ❑ Build Public Awareness and Risk Prevention Culture.

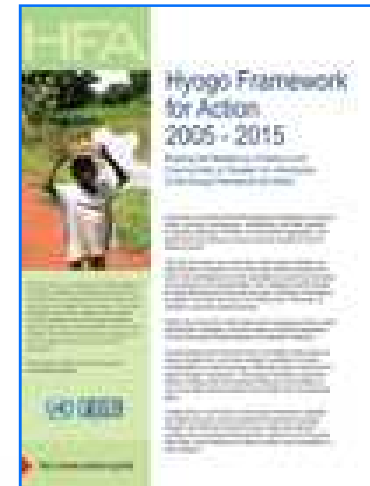


HYOGO FRAMEWORK FOR ACTION (HFA) 2005 – 2015 STRATEGIC GOALS

“Building the Resilience of Nations and Communities to Disasters”

- Ratified in January 2005 by over 4000 representatives of governments, non-governmental organisations (NGOs), academic institutions, and the private sector gathered in Kobe, Japan, at the second World Conference on Disaster Reduction (WCDR).

- Adopted by 168 states as a ‘Framework for Action’



Scope

Develop a state-of-the-art system to assess, monitor, mitigate, and update the seismic hazard and risk in the Emirate of Abu Dhabi

- ❑ Seismology & Earthquake Engineering studies
- ❑ Seismic Monitoring Networks
- ❑ SRMMC and GIS-Seismic Database



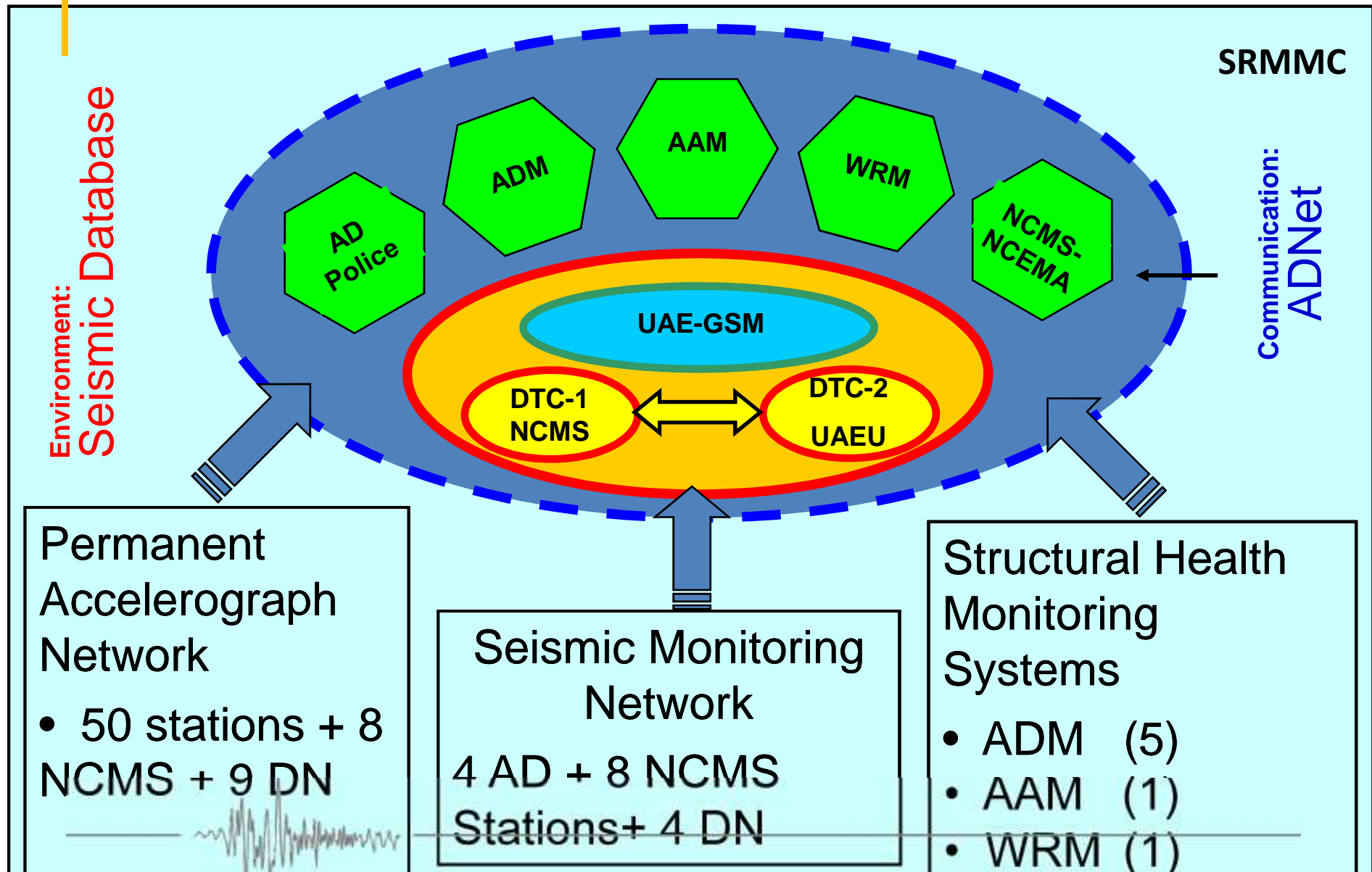
Project Structure



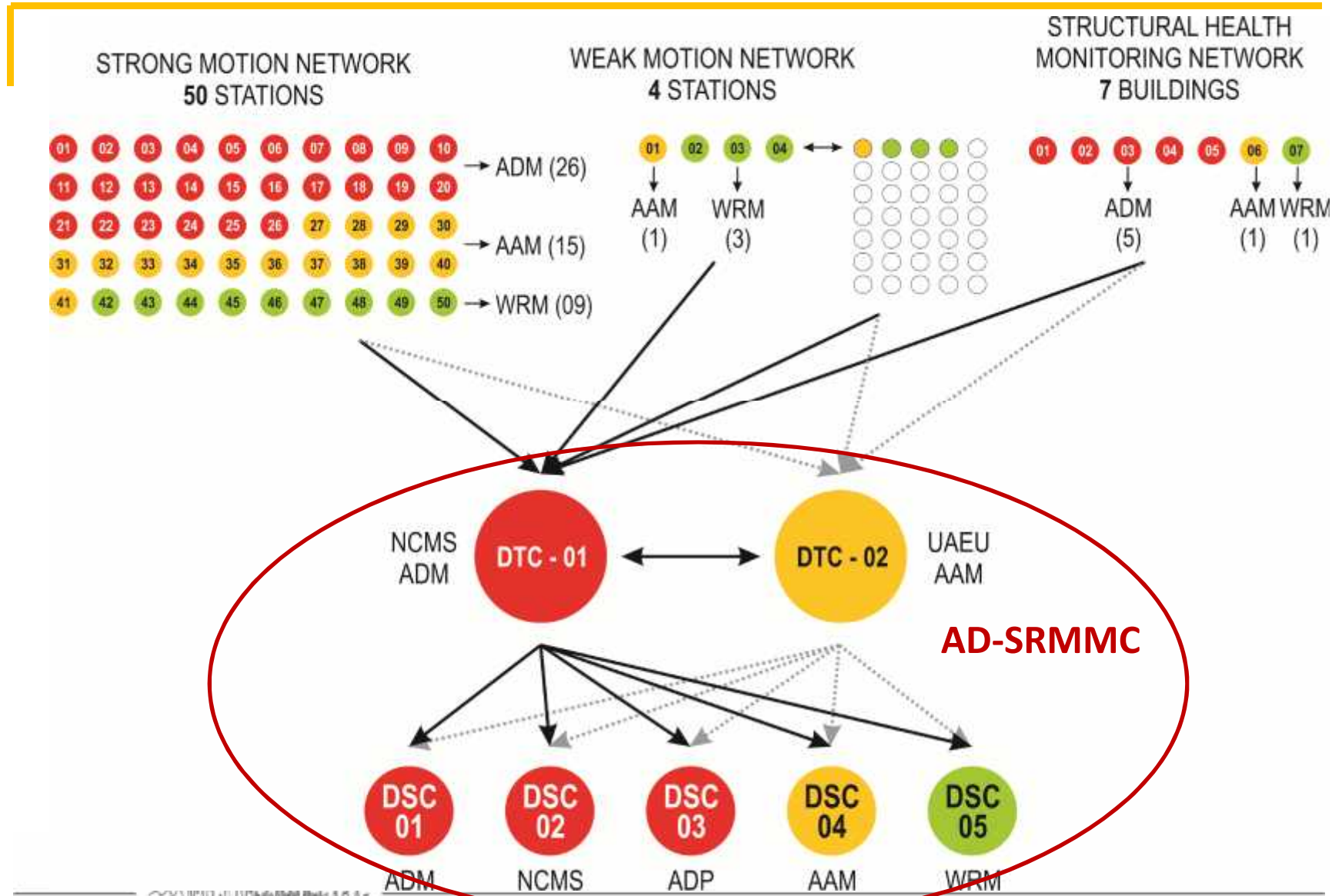
1. Seismic Hazard Assessment and Seismic Zoning of UAE	11. 3D Seismic Simulation model to Simulate Long Period Seismic Waves
2. Site Amplification Studies and Microzonation	12. Seismic Performance and Risk of ADM Tall Buildings to Simulated Long-period Seismic Waves
3. Liquefaction Susceptibility Study and Microzonation	13. Seismic Risk Assessment and Loss Estimation
4. AD Seismic Parameters Web	14. AD Seismic Risk Monitoring and Management Centre (AD-SRMMC)
5. Seismic Risk Analysis of Four Critical Importance Lifeline Systems	15. Seismic Data Base and GIS Shell for Management, Maintenance and Modification of Seismic Data Base Products
6. Seismic Risk Analysis of Critical Structures	16. Coordinated Activities
7. AD Permanent Accelerograph Network	17. Promotion/Validation & Public Awareness
8. AD Seismic Monitoring Network	18. Training
9. UAE Ground Shaking Map (UAE-GSM) System	19. BOT (build-Operate-Transfer) Services
10. Structural Health Monitoring System for Unique Structures	20. Maintenance of the System



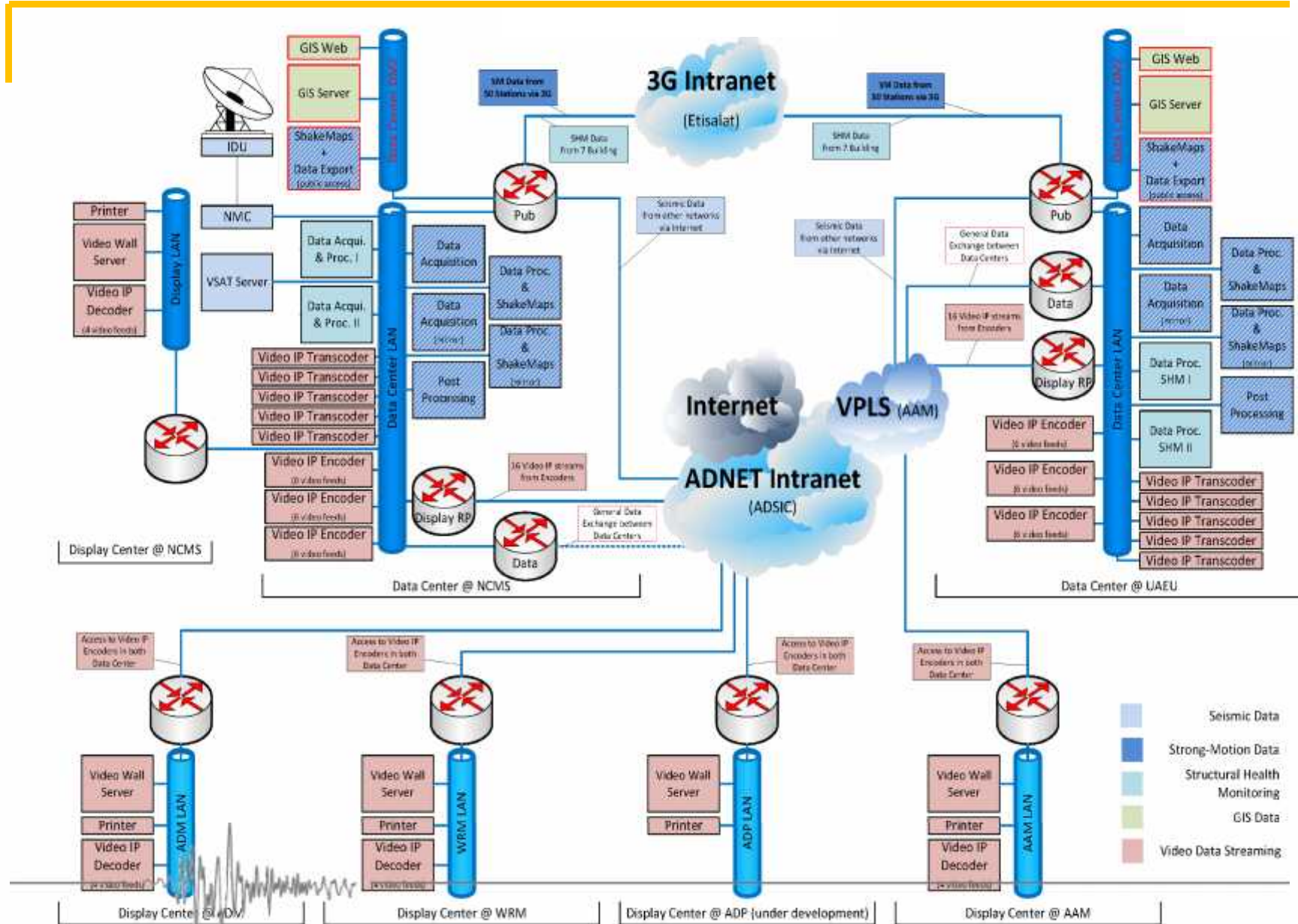
System Architecture



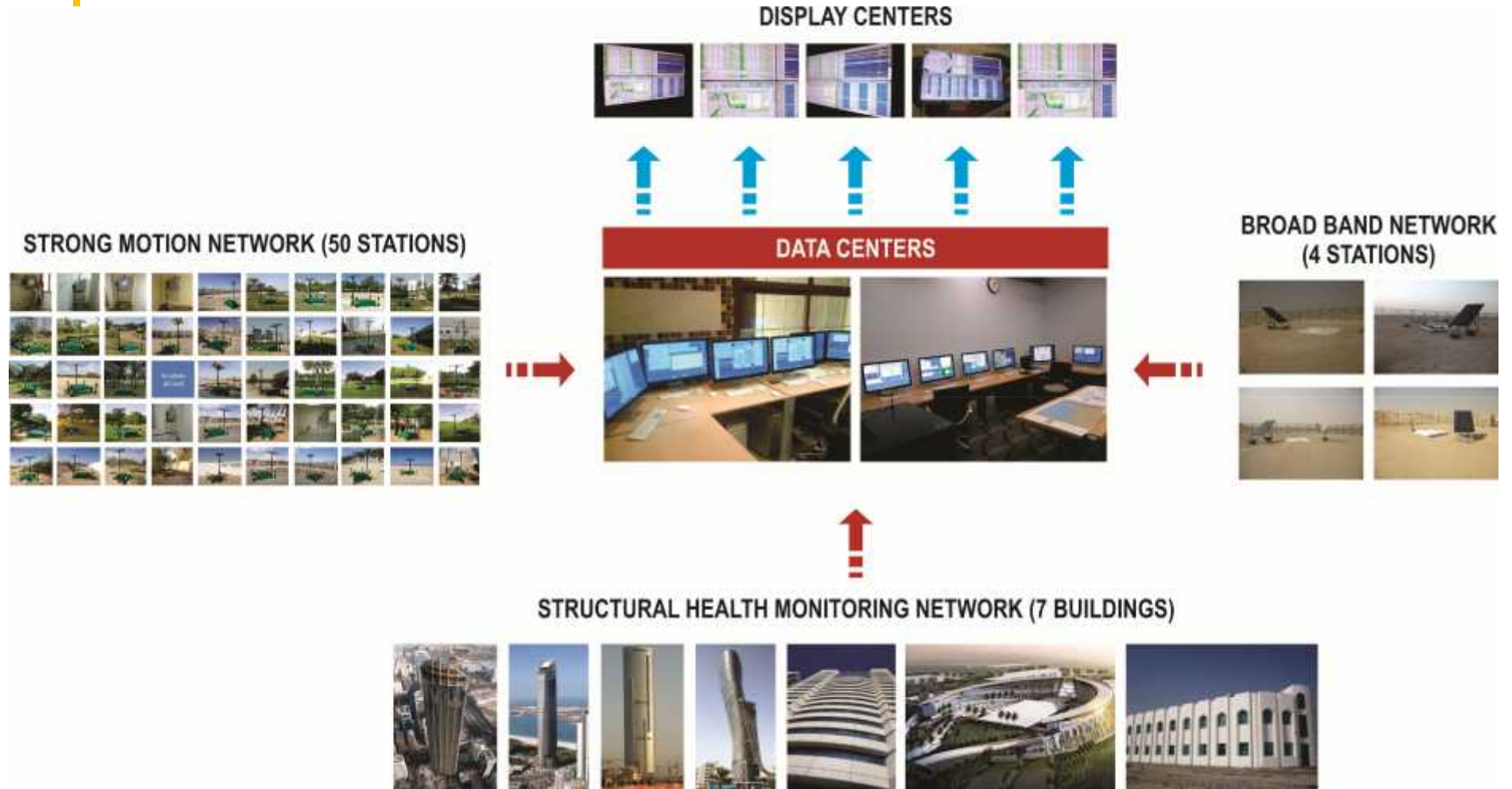
SRMMC CENTRE



SRMMC CENTRE



SRMMC CENTRE



Display Centers

- Graphic User Interfaces via X-forwarding waveform data, event map, datalogger state-of-health
- Web-pages of ShakeMap and the WebGIS



SEISMIC STATIONS AND INSTRUMENTATION

Network	Digitizer	Sensor	Installation Date
DN	Q330	STS-2 4 Episensor 9	2006
NCMS	Trident	Trillium 120 8 Titan 8	2008, 2009, 2013
GSN- UOSS	Q330HR	STS-2.5 1 Episensor EST 1	2009
ADM	Q330 Basalt	Guralp CMG-3T 4 Episensor EST 5 SBEPI 52	2012

BB 17

SM 76



BB Network



Ghayathi



Sila'a



Um Zummoul



Madinat Zayed

SM Network



Municipality
Delma



Sir Bani Yas
Island



Municipality
Liwa



Town Planning
Madinat Zayed



TAMM Center
Ghayathi



TAMM Center
Marfa



ADNOC Housing
Ruwais



Al Hayer Park
Al Ain



Dolphin Park
Abu Dhabi



Al Yahar Park
Al Ain



ENEC, Braka



Al Mushrif Ladies
& Children
Park AD



Beach 30 & Khalifa
Bin Shakhbout

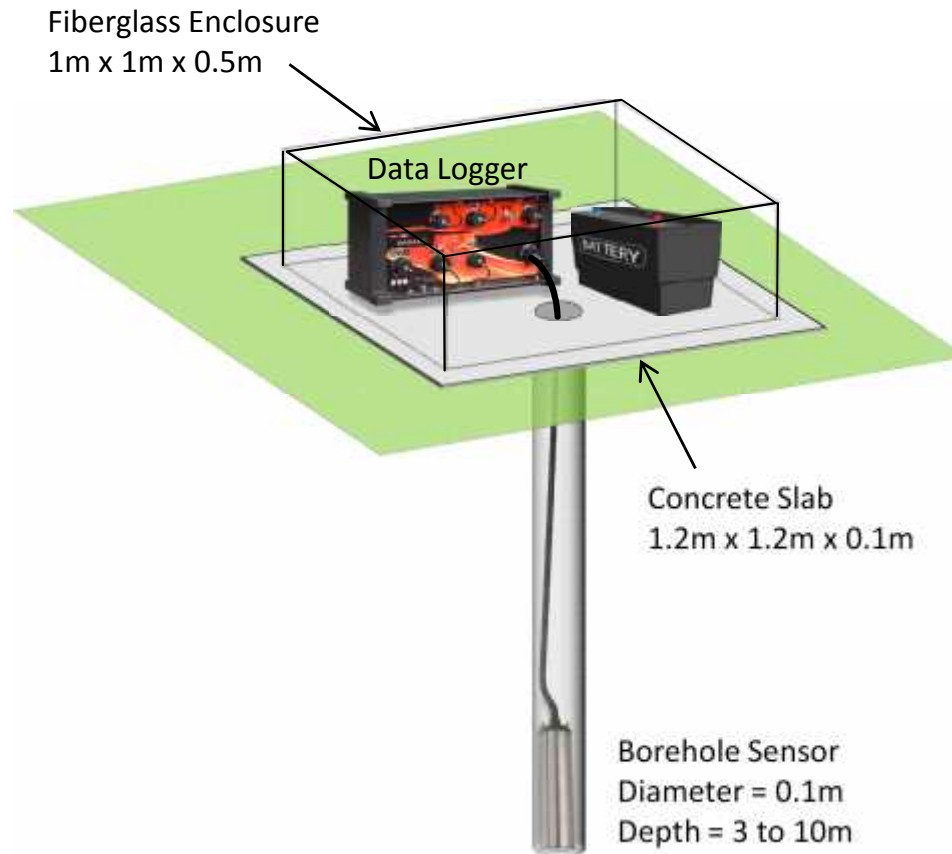


Mazyad Mashtal
Al Ain



Al Falah 9 & Al
Karamah 24, AD

SEISMIC STATIONS AND INSTRUMENTATION



Station Site characterization

Job Ref. ADRS/1105016		BOREHOLE No. 39	
Project Name		EAD Permanent Accelerograph Network	
Project Location		Al Raha Beach - Abu Dhabi Golf Club Green Area	
Client		M/s. Zetas	
Request No.		ADAG/16	
Date of Drilling		28/10/2011 to 30/10/2011	
Coordinates		N: 25°02'00.00" E: 55°07'00.00" Elevation: 40.00m	
Drilling Fluid		Water / Gasparan GWL: 250.000-450	
Equipment		Sonic Drill / Hammer DSR/3	

Depth (m)	SPT Blows	Description of Strata	Depth		Sample No.	N ₆₀	OCR	RDB	Notes
			From (m)	To (m)					
0.00	0.00	0.70	B	1					
0.70	1.00	B	2						
1.00	1.50	B	3						
1.50	1.50	B	4						
2.00	2.40	S	5						
2.40	3.00	B	6						
3.00	3.50	S	7						
3.50	3.00	B	8						
4.00	4.00	S	9						
4.00	4.40	B	10						
4.40	4.40	B	11						
5.00	5.40	S	12						
5.40	6.00	B	13						
6.00	6.50	B	14						
7.00	7.40	S	15						
7.40	8.00	B	16						
8.00	8.40	S	17						
8.40	9.00	B	18						
9.00	9.50	S	19						
9.50	10.00	B	20						

P.S. SUSPENSION LOGGING

Report Ref: ADRS/1105016
 Client: M/s. Zetas
 Project: EAD Permanent Accelerograph Network
 Borehole No.: 39
 Location: Al Raha Beach - Abu Dhabi Golf Club Green Area
 Test Date: 08/11/2011
 Report Date: 08/11/2011

Depth (m)	Vs Right (m/s)	Vs Left (m/s)	Vs Average (m/s)	Vp (m/s)
3.00	274	287	280.5	1278
4.00	270	282	276.0	1254
5.00	174	166	170.0	1108
6.00	183	175	189.0	1100
7.00	182	192	187.0	1156
8.00	200	198	194.0	1172
9.00	180	189	184.5	1148
10.00	179	198	173.5	1116
11.00	237	272	204.5	1228
12.00	294	274	279.0	1280
13.00	296	306	300.0	1402
14.00	302	291	298.0	1380
15.00	237	250	243.5	1314
16.00	1290	1300	1302.0	3780
17.00	1635	1709	1700.0	4838
18.00	1643	1660	1651.5	3825
19.00	780	794	772.0	2222
20.00	872	888	880.0	2279
21.00	740	793	769.5	2161
22.00	649	697	640.5	2194
23.00	626	634	630.0	2290
24.00	651	676	670.0	2383
25.00	745	738	742.0	2100
26.00	657	668	662.5	2364
27.00	1296	1290	1273.0	3648
28.00	815	826	820.5	2282
29.00	720	738	741.0	1982
30.00	730	742	736.0	2083



NEHRP Site Class

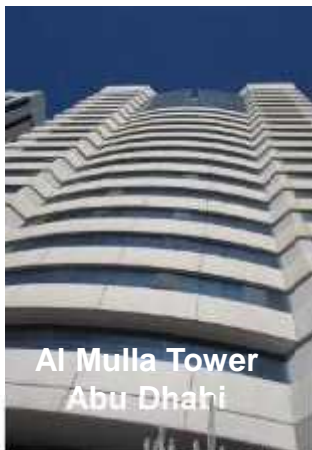
Site Classifications taken from Table 1615 1.1 Site Class Definitions published in 2000 International Building code, International Code Council, Inc. on page 350.

Site Class Definitions partially reproduced below

Site Class	Soil Profile Name	Average Properties in Top 100 feet (as per 2000 IBC section 1615.1.5) Soil Shear Wave Velocity, V_s	
		Feet/second	Meters/second
A	Hard Rock	$V_s > 5000$	$V_s > 1524$
B	Rock	$2500 < V_s \leq 5000$	$762 < V_s \leq 1524$
C	Very dense soil and soft rock	$1200 < V_s \leq 2500$	$366 < V_s \leq 762$
D	Stiff soil profile	$600 < V_s \leq 1200$	$183 < V_s \leq 366$
E	Soft soil profile	$V_s < 600$	$V_s < 183$



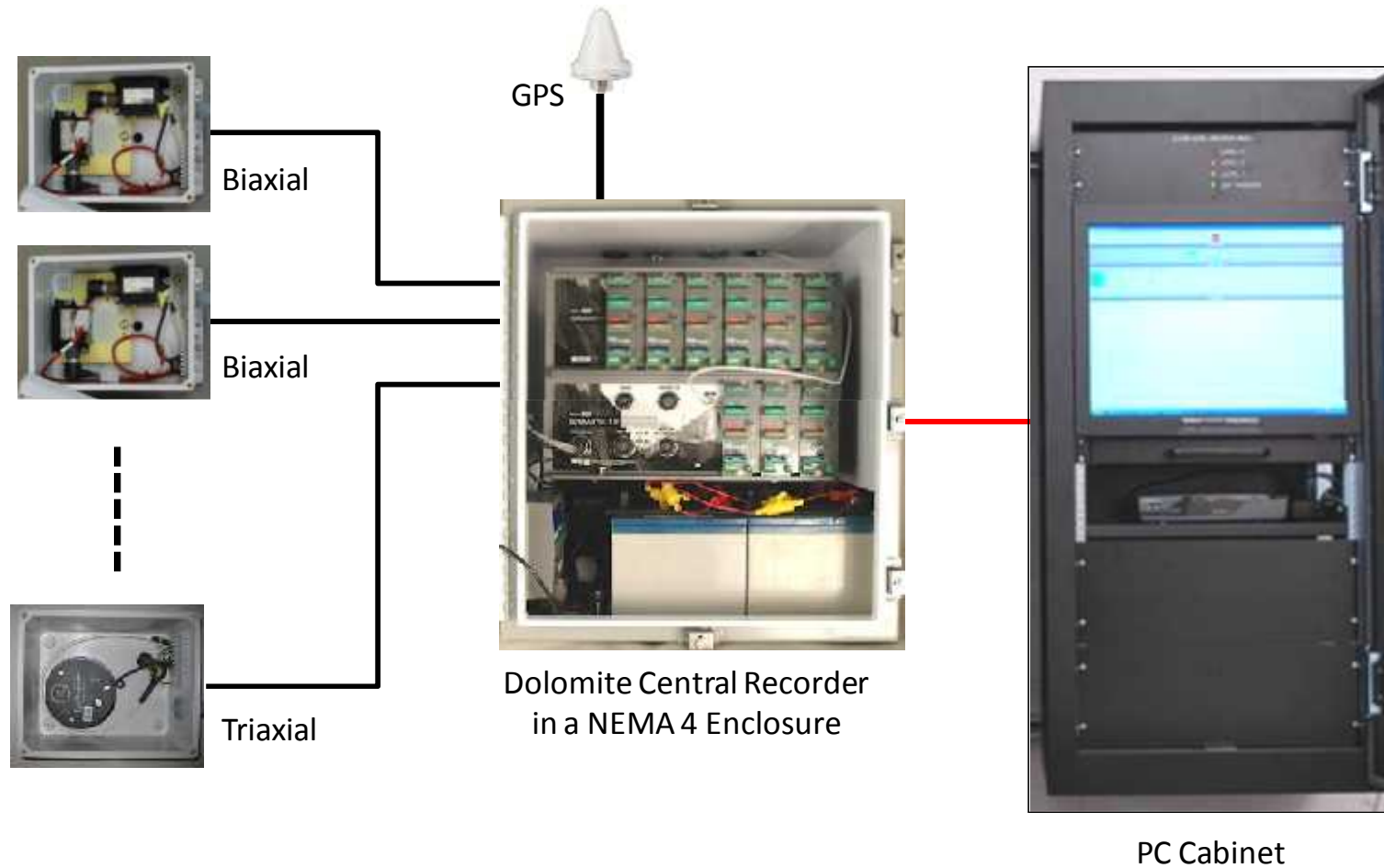
SHM System



ID	BUILDING	LOCATION	FLOORS	HEIGHT
1	The Landmark	Abu Dhabi	72	324m
2	ADNEC Capital Gate	Abu Dhabi	35	164m
3	Sky Tower	Al Reem Island	74	312m
4	Central Market Trust Tower	Abu Dhabi	58	278m
5	Almulla Tower	Abu Dhabi	20	75m
6	UAEU Crescent Building	Al Ain Region	4	30m
7	Madinat Zayed Hospital	Western Region	2	10m



SHM System



SENSOR DESCRIPTION

Shallow Borehole Episensor SBEPI

- Triaxial Accelerometer (3-ch)
- In 30m borehole near building
- One (1) per building

EpiSensor ES-T

- Triaxial Accelerometer (3-ch)
- On foundation slab
- One (1) per building

EpiSensor ES-U2

- Uniaxial Accelerometer (1-ch)
- Distributed on floors
- In uniaxial & biaxial configurations
- 16 to 28 per building

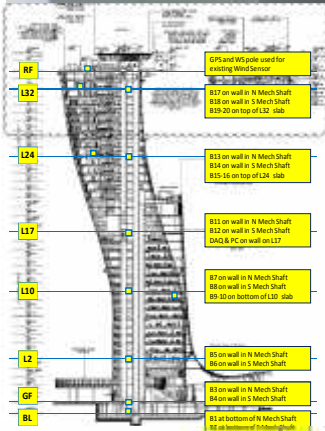
WindObserver II Ultrasonic Anemometer

- Wind Speed & Direction Sensor (2-ch)
- Located on Roof
- One (1) per building

Sensors



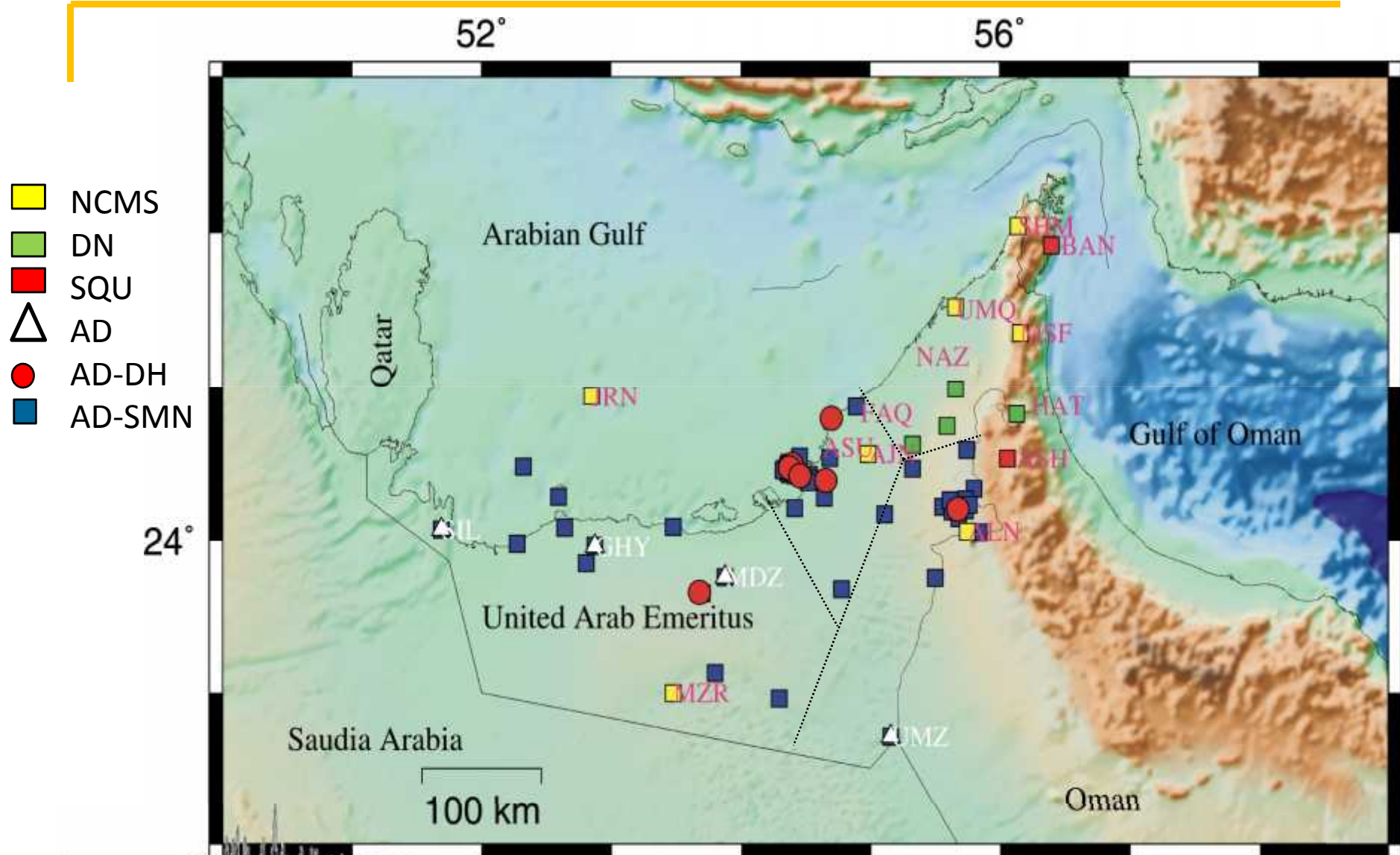
SHM System



CAPITAL GATE TOWER
36 Channels



UAE National Seismic Network, NCMS



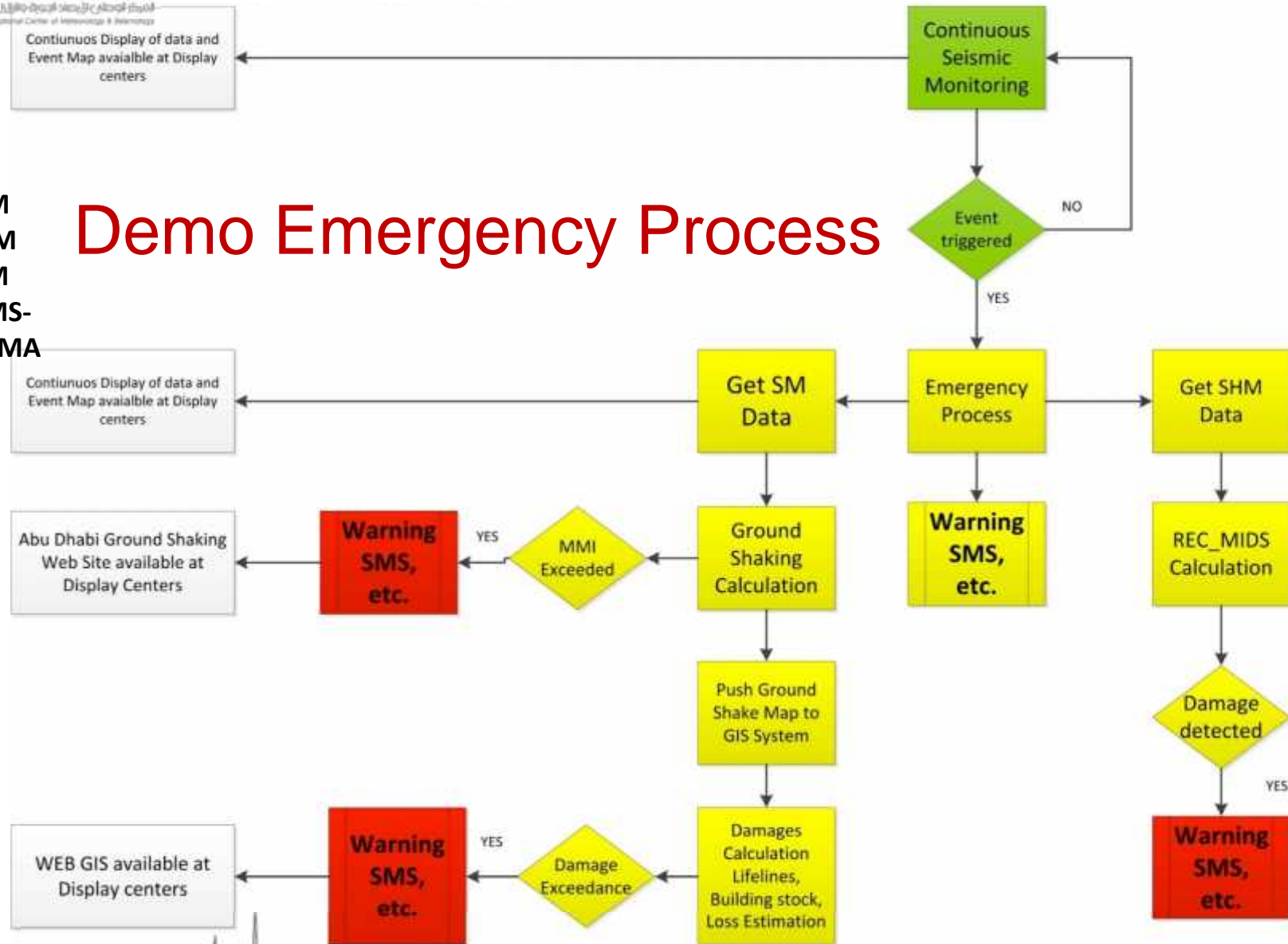


المركز الوطني للمeteorology & Seismology
National Center of Meteorology & Seismology
Continuous Display of data and Event Map available at Display centers



ADP
ADM
WRM
AAM
NCMS-
NCEMA

Demo Emergency Process



Web Based Content

- ShakeMap
- Web GIS Content
 - Damage estimations of life lines & buildings
 - Casualty estimation
 - PGA per grid



ADHRA 6MM6 INFORMATION MESSAGE

Alert Level (AE): ALERT ON
Alert Level (UA): ALERT ON

Earthquake on 09 Apr 2013 11:52:50 (GMT)

Main Status:
Region: SOUTHERN IRAN
527km NW from Abu Dhabi
150km SW from Shiraz
302km SW from Ahadan

Event ID - 4373
Revision - 9556
Latitude - 28.4996
Longitude - 51.5507
Origin time - 04/09/2013 11:52:50 (GMT)
Depth - 10.0km

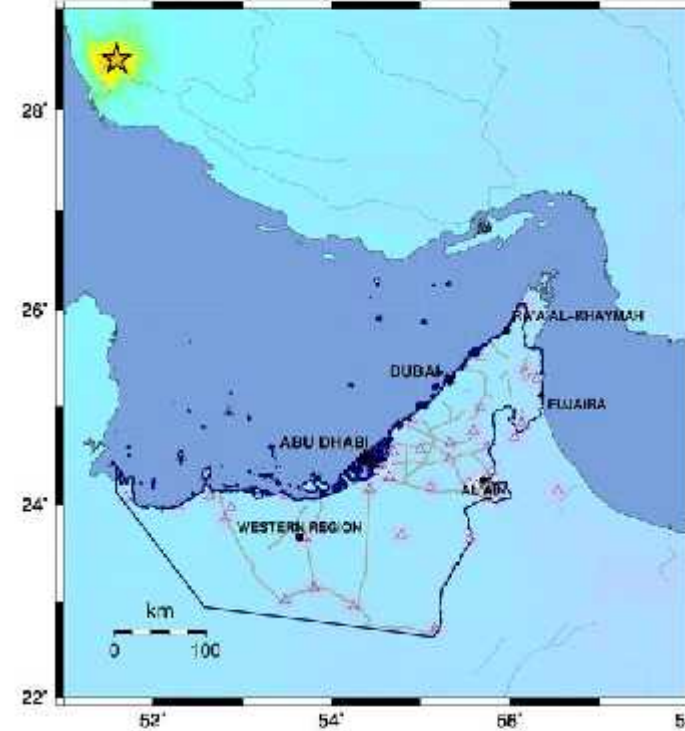
Epicentral Intensity: 7.7
Magnitude: 6.3 (Mw)

Intensity by cities:

CITY	Distance(km)	Intensity
ABU DHABI EMIRATE		
Abu Dhabi	527	3.1
Al Ain	634	2.9
Rasays	501	3.1
Bosha	673	3.1
Tarif	560	2.7
Sila	490	3.1
Arada	609	3.1
Bu Hasa	576	3.2
Mozaira	635	2.6
Sociman	583	3.2
Al Wilah	660	3.1
Al Sahba	531	3.1
Shabarah	530	3.1
Al Garha	529	3.2
Al Khatim	577	1.6
As Shabaikh	601	2.6

UAH	Distance(km)	Intensity
Dubai	514	3.1
Sharjah	510	3.2
Rajairah	602	2.9
Em al Faywayn	510	3.6
Ras al Khaymah	525	2.9
Ajman	513	3.3
Mawa Fakhan	509	3.1
Diba	560	3.4
Mina Jabal Ali	510	3.1
Al Fay	581	3.2

Municipality of Abu Dhabi City and NCMS ShakeMap : SOUTHERN IRAN
Tue Apr 9, 2013 03:52:50 PM GST M 6.3 N 28.50 E 51.55 Depth: 10.0km ID:4373



Map Version 4 Processed Tue Sep 24, 2013 09:07:07 PM MSD

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	None	None	None	Very light	Light	Moderate	Mod. Heavy	Heavy	Very Heavy
PEAK ACC (mg)	<0.05	0.5	2.8	5.2	12	22	40	75	>120
PEAK VEL (cm/s)	<0.01	0.7	7.4	4.7	8.6	20	41	85	>175
INTEGRATED INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X

Scale based upon Woodruff et al. (2010)

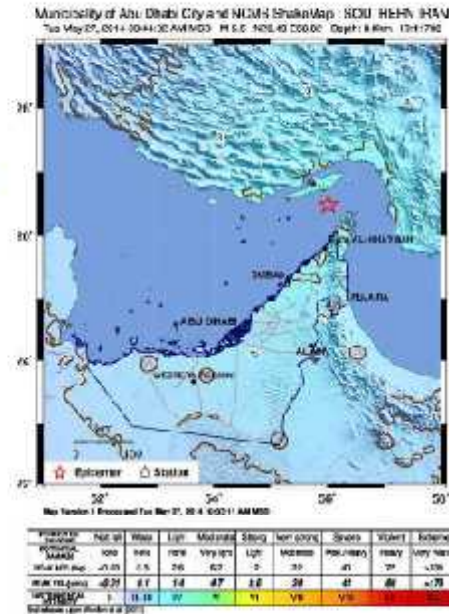
Earthquake on **27/05/2014** at **00:44:32** (Local Time) with Magnitude **5.5 (Mwp)**

Alert Level (AUE): **NO ALERT**
Alert Level (UAE): **ALERT ON**
(Warning: Alert level maybe revised if necessary ...)

Event ID = **11736**
Latitude = **26.4918**
Longitude = **55.0154**
Depth = **8.0km**

Epicentral Intensity: **VII**
Magnitude: **5.5 (Mwp)**

Region: **SOUTHERN IRAN**
270km NE from Abu Dhabi
106km NE from Dubai
52km NNW from Ash Sham



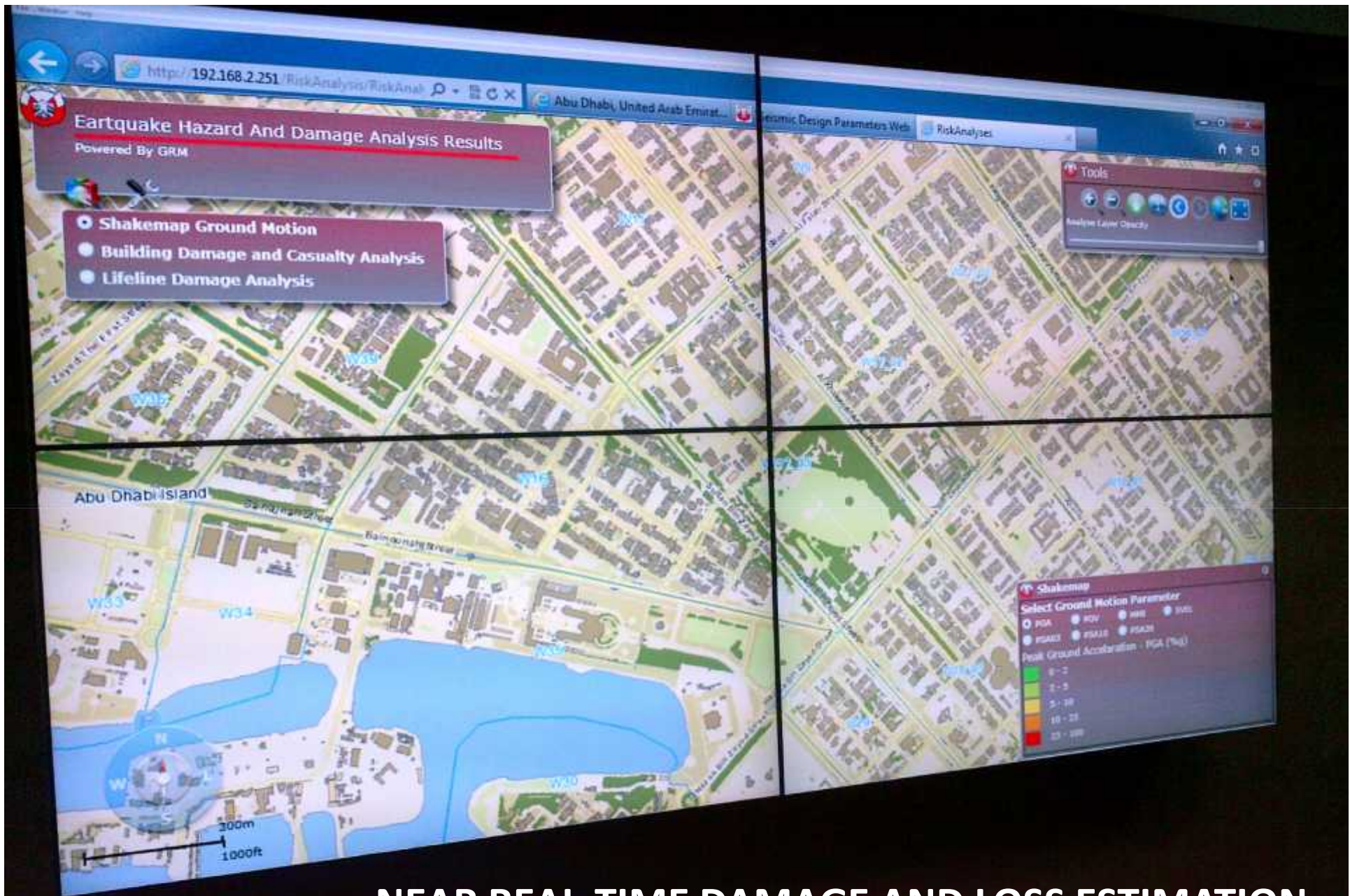
Intensity of Main Cities

City	Dist(km)	Intensity(MMI)	Perceived Shaking	Potential Damage
Abu Dhabi	270	III	Weak	none
Al Ain	257	III	Weak	none
Al Ruwaha	423	III	Weak	none
Madinat Zayed	393	III	Weak	none
Duba	156	III	Weak	none
Sharjah	140	III	Weak	none
Al Fujairah	156	III	Weak	none
Umri al Qaywayn	113	III	Weak	none
Ras al Khaymah	78	III	Weak	none
Ajman	133	III	Weak	none
Diba Al Fujairah	100	II	Weak	none

Special Report will be added by NCMS

this is a preliminary result not yet reviewed by seismologist
Message generated on **27/05/2014** at **10:33:51** (CST)





NEAR REAL-TIME DAMAGE AND LOSS ESTIMATION



The Sixth International Conference on "Seismology, Earthquake Engineering and Antelope Users Group meeting" May 29-31, Baku, 2014



THANK YOU

The Sixth International Conference on “Seismology, Earthquake Engineering and Antelope Users Group meeting” May 29-31, Baku, 2014

Achieved strategic goals

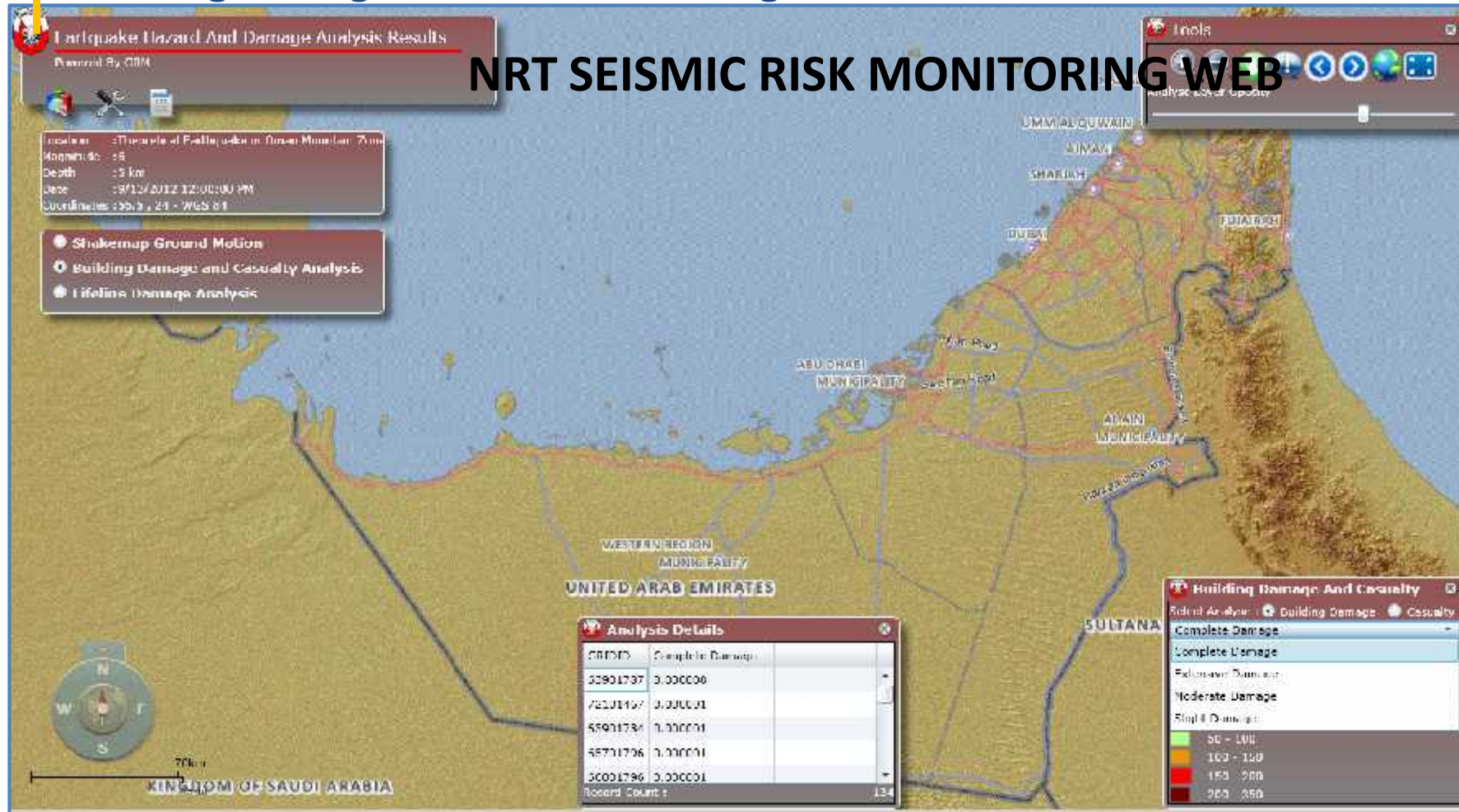
- ❑ Qualitative and quantitative understanding of seismic environment the UAE is subjected to, as a base for development of seismic design regulatory framework and urban planning.
- ❑ Establishment of UAE Ground Shaking Map (UAE-GSM) system for automatic real time acquisition of ground shaking parameters and dissemination of emergency response decision parameters.
- ❑ Establishment of maintainable GIS oriented Seismic Database as an umbrella for seismic risk monitoring and management.



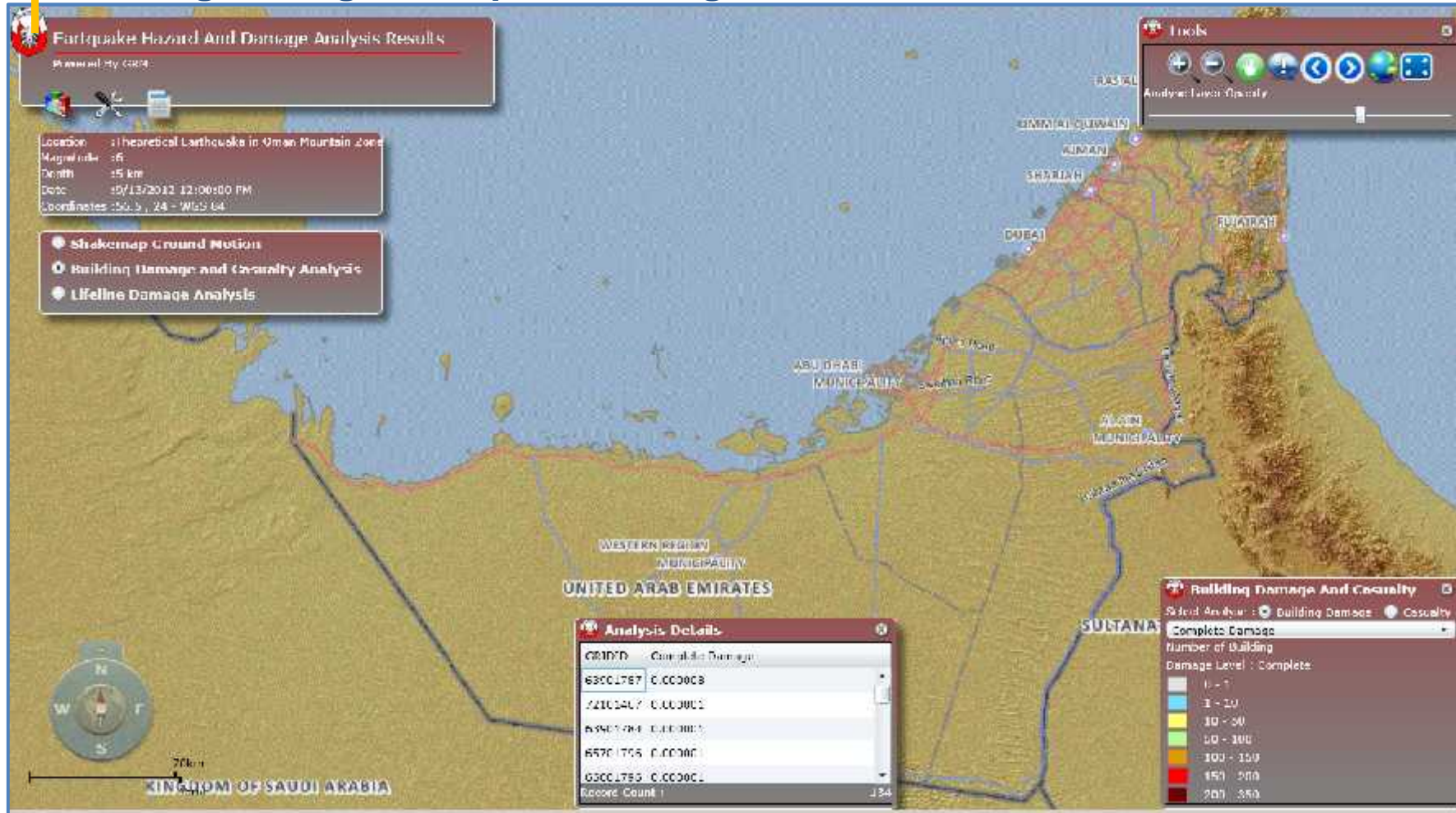
NRT SEISMIC RISK MONITORING WEB



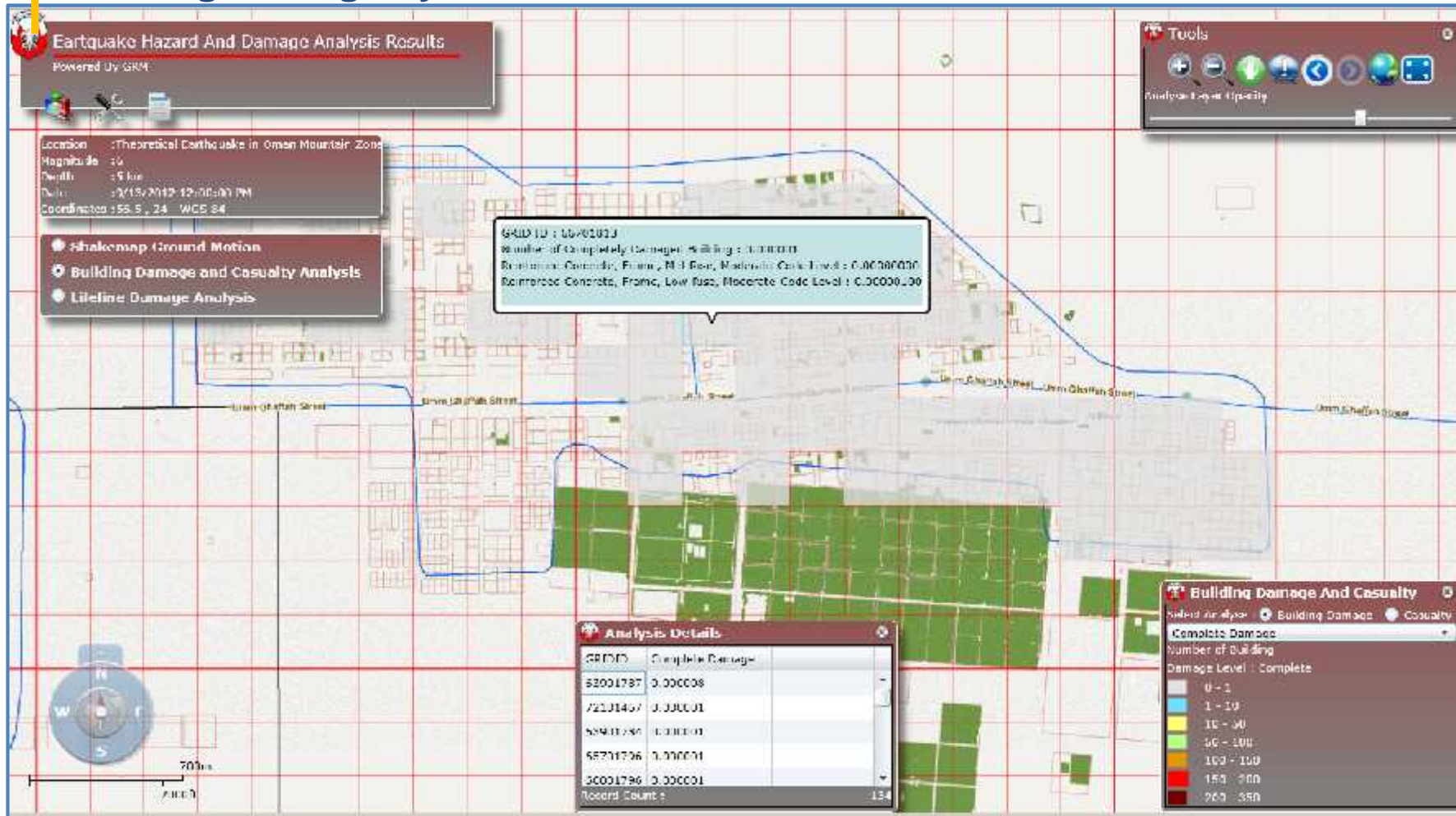
Building Damage, Selection of Damage Level



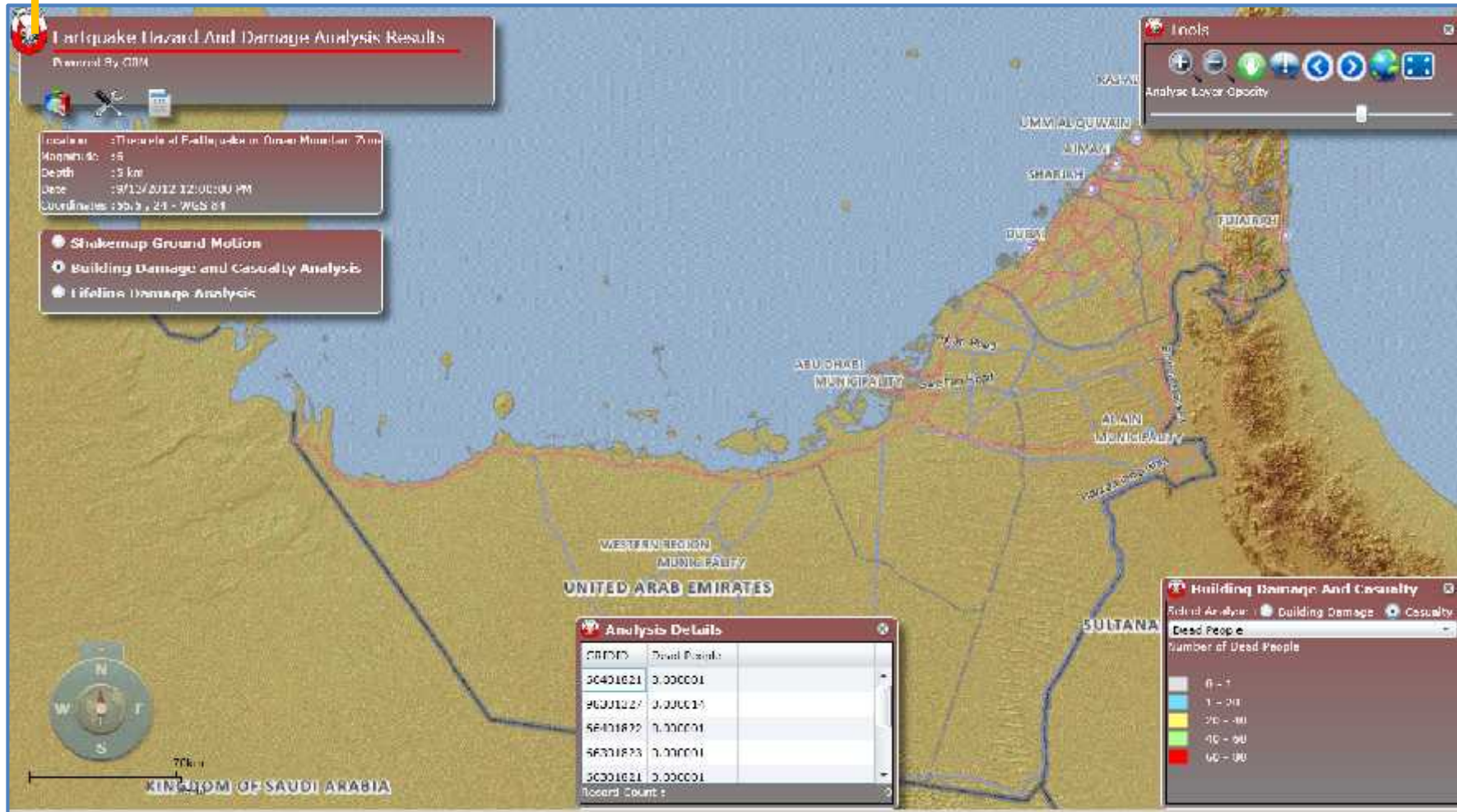
Building Damage, Complete Damage



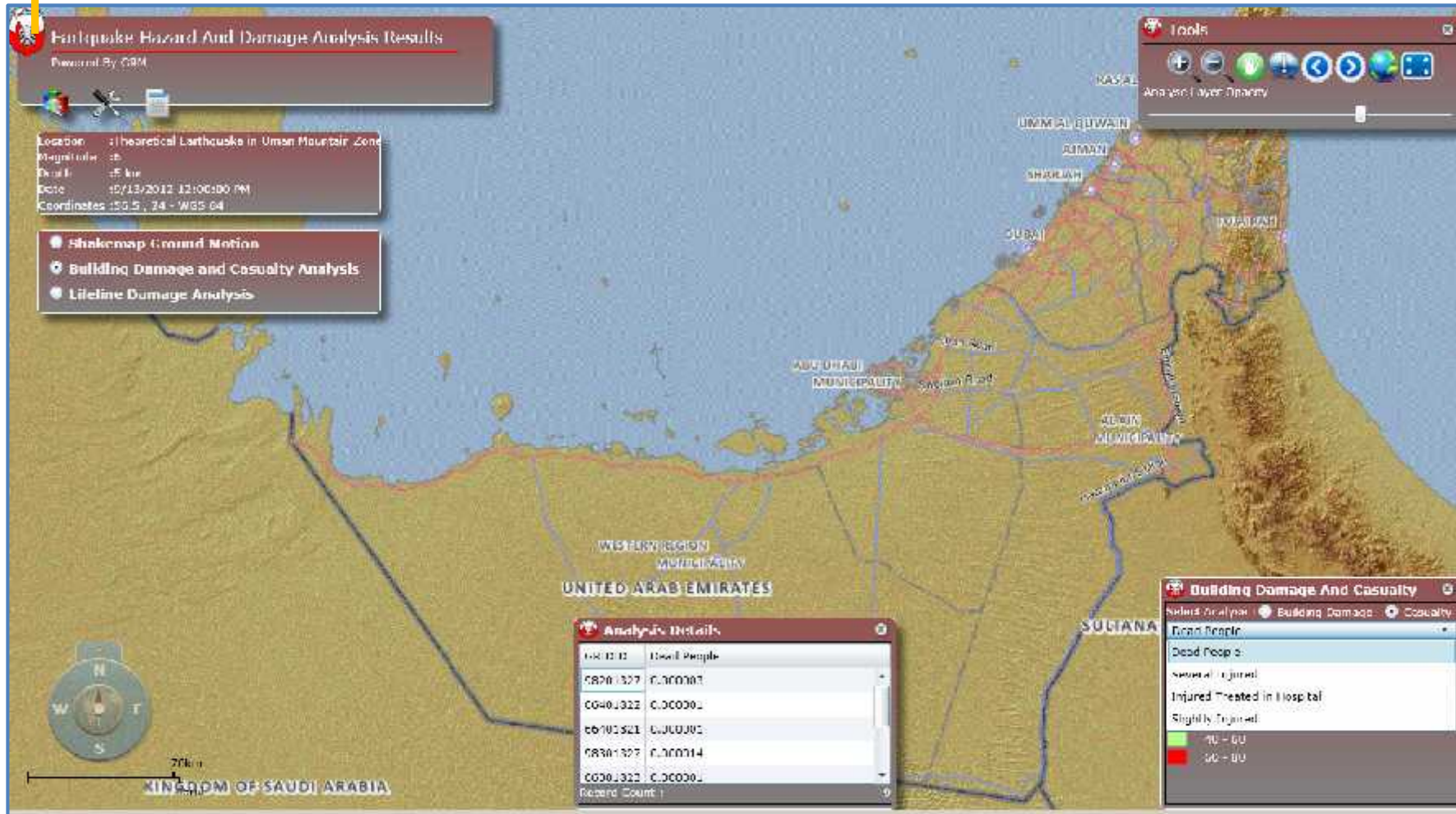
Building Damage by BTM



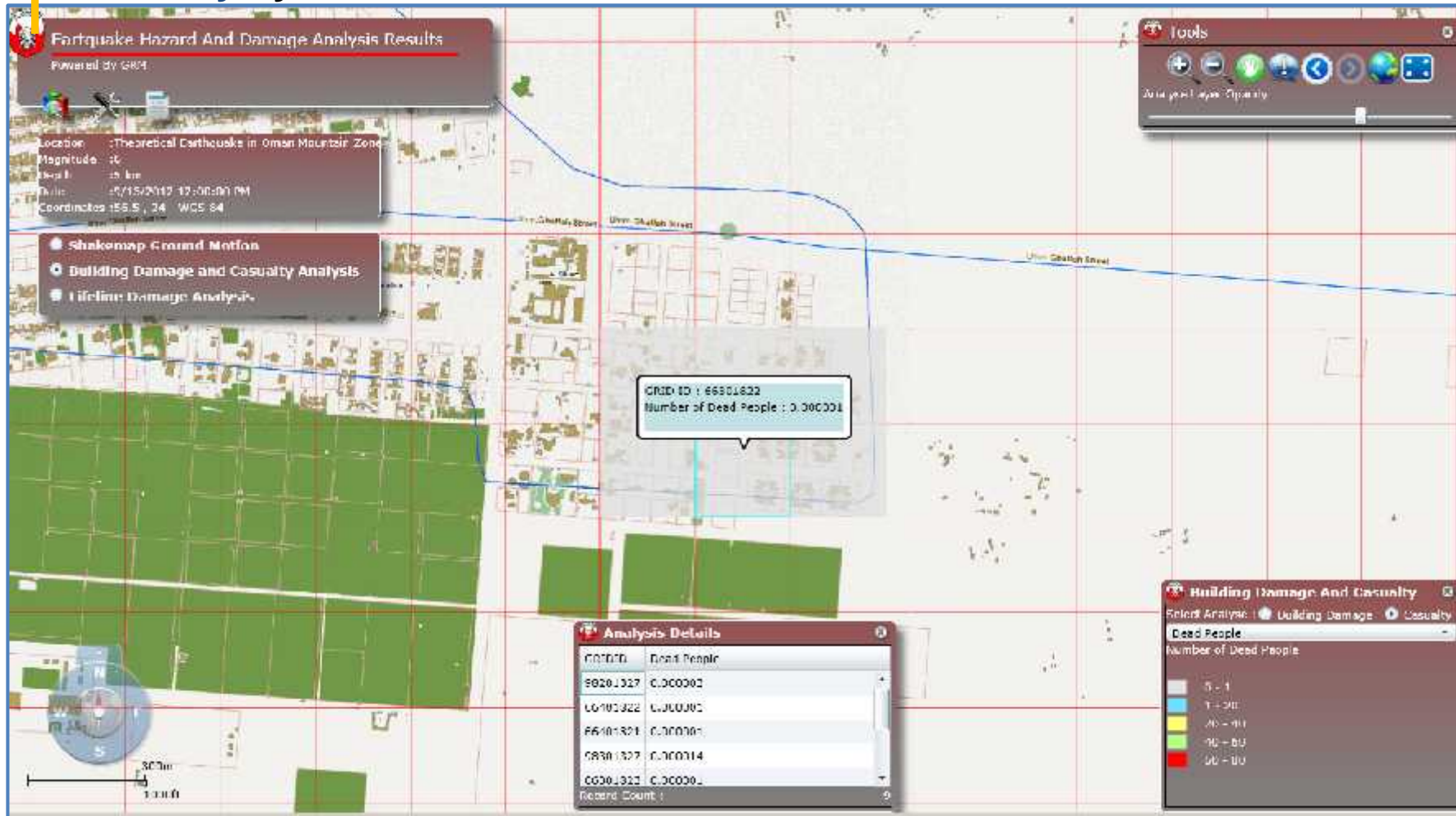
Casualty by Severity Level



Casualty Results, Selection of Severity Level



Casualty by Grid Cells



NRT AGGREGATED CASUALTY AND BUILDING DAMAGE REPORT



Casualty and Building Damage Report



Earthquake Information

Latitude : 27.84 Longitude : 61.84 Magnitude : 7.68 Depth : 97.52
14 5 27 km

Date/Time : 4/16/2013 10:44:21 AM

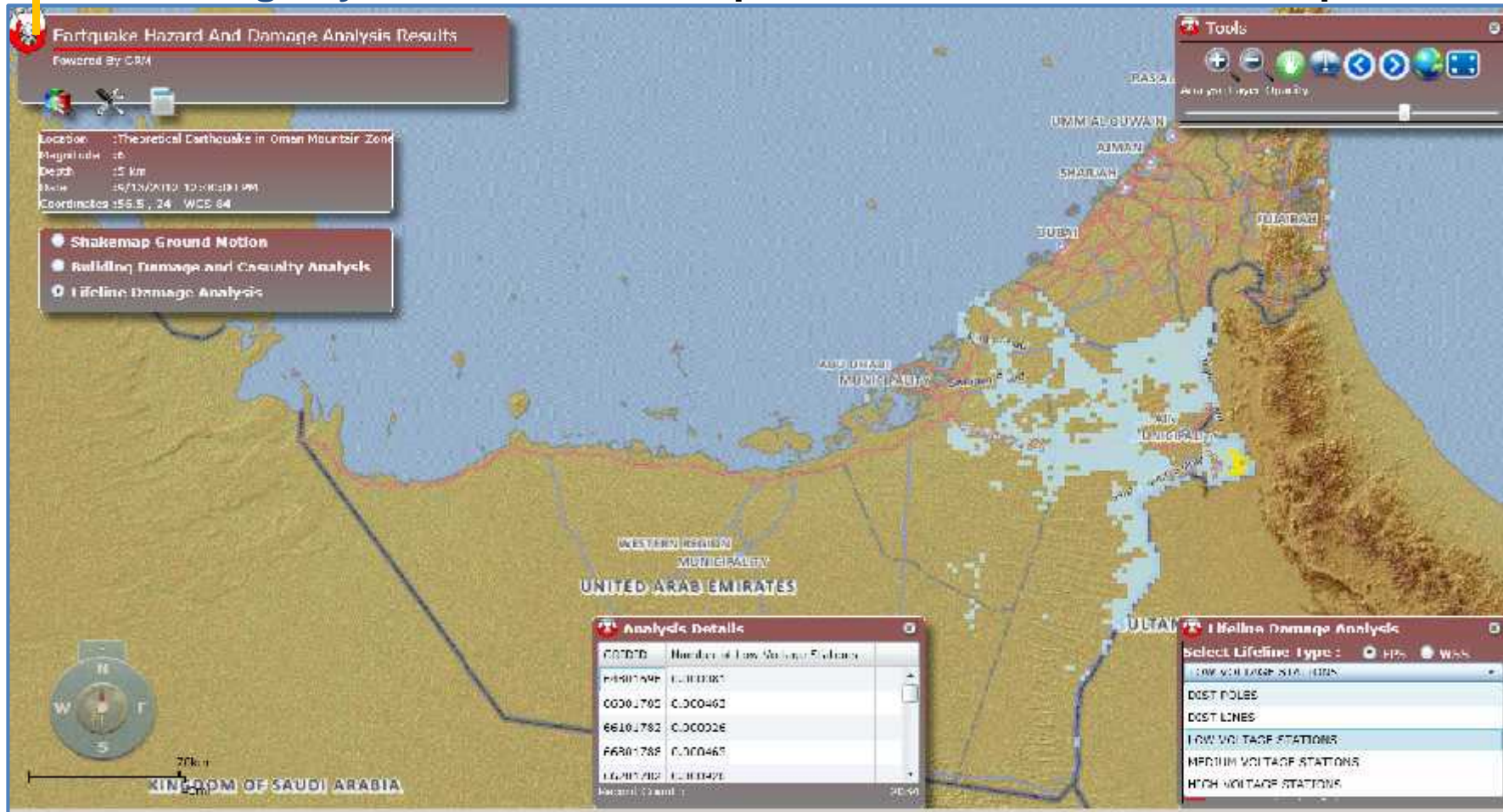
Description : SOUTHERN TRAN

Report Date/Time : 4/16/2013 4:49:34 PM

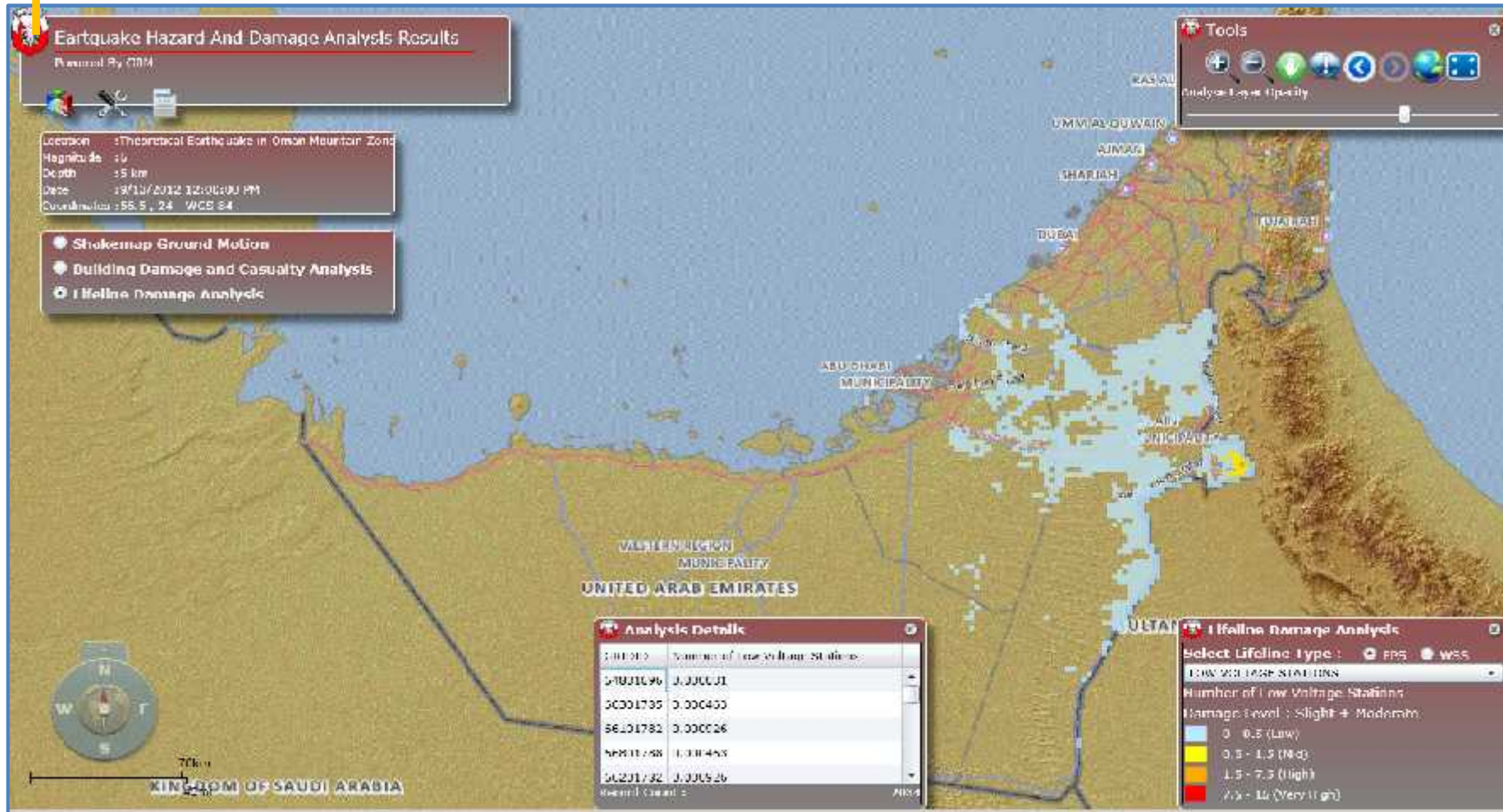
Municipality	Location			Casualty				Building Damage				Coordinates		Emergency Grid
	District	Sector	Level 1	Level 2	Level 3	Level 4	Slight	Moderate	Extensive	Complete	Lat	Long		
Al Ain	AL SALAMA	Al Salamat 2	0.0015	0.0002	0	0	0.0865	0.0379	0.0076	0.0003	24.2167	55.5854	1	
Abu Dhabi	Al Shahama	Al Shahama	0.0011	0.0001	0	0	0.0852	0.0413	0.0062	0.0004	24.5334	54.6848	2	
Abu Dhabi	Abu Dhabi Island	W17	0.0008	0.0001	0	0	0.0577	0.0254	0.0048	0.0007	24.4303	54.407	3	
Abu Dhabi	Abu Dhabi Island	E4_02	0.0032	0.0004	0	0	0.0301	0.0133	0.0022	0.0001	24.48486	54.37031	4	
Abu Dhabi	Abu Dhabi Island	F11_01	0.0006	0.0001	0	0	0.0293	0.0126	0.0026	0.0001	24.4115	54.4357	5	
Abu Dhabi	Abu Dhabi Island	W14_02	0.0012	0.0001	0	0	0.028	0.0115	0.0023	0.0001	24.46459	54.37167	6	
Abu Dhabi	Abu Dhabi Island	E18_02	0.0024	0.0003	0	0	0.0279	0.0112	0.0018	0.0001	24.4784	54.3758	7	
Abu Dhabi	Abu Dhabi Island	F11	0.001	0.0001	0	0	0.0277	0.0116	0.0021	0.0001	24.43591	54.43467	8	
Abu Dhabi	Abu Dhabi Island	W9	0.0014	0.0002	0	0	0.0266	0.0107	0.0019	0.0001	24.4694	54.3501	9	
Abu Dhabi	Abu Dhabi Island	W14_01	0.0004	0	0	0	0.0265	0.0115	0.0023	0.0001	24.46055	54.36685	10	
Abu Dhabi	Abu Dhabi Island	E18_01	0.0021	0.0002	0	0	0.0265	0.011	0.002	0.0001	24.4747	54.3704	11	
Abu Dhabi	Abu Dhabi Island	W24_02	0.0009	0.0001	0	0	0.0262	0.0116	0.0019	0.0001	24.45172	54.38376	12	
Abu Dhabi	Al Shahama	Al Shahama Old	0.0008	0.0001	0	0	0.0249	0.0107	0.0022	0.0001	24.5179	54.6817	13	
Abu Dhabi	Musaffah	M11	0.0004	0	0	0	0.0246	0.0103	0.0022	0.0001	24.364	54.50653	14	



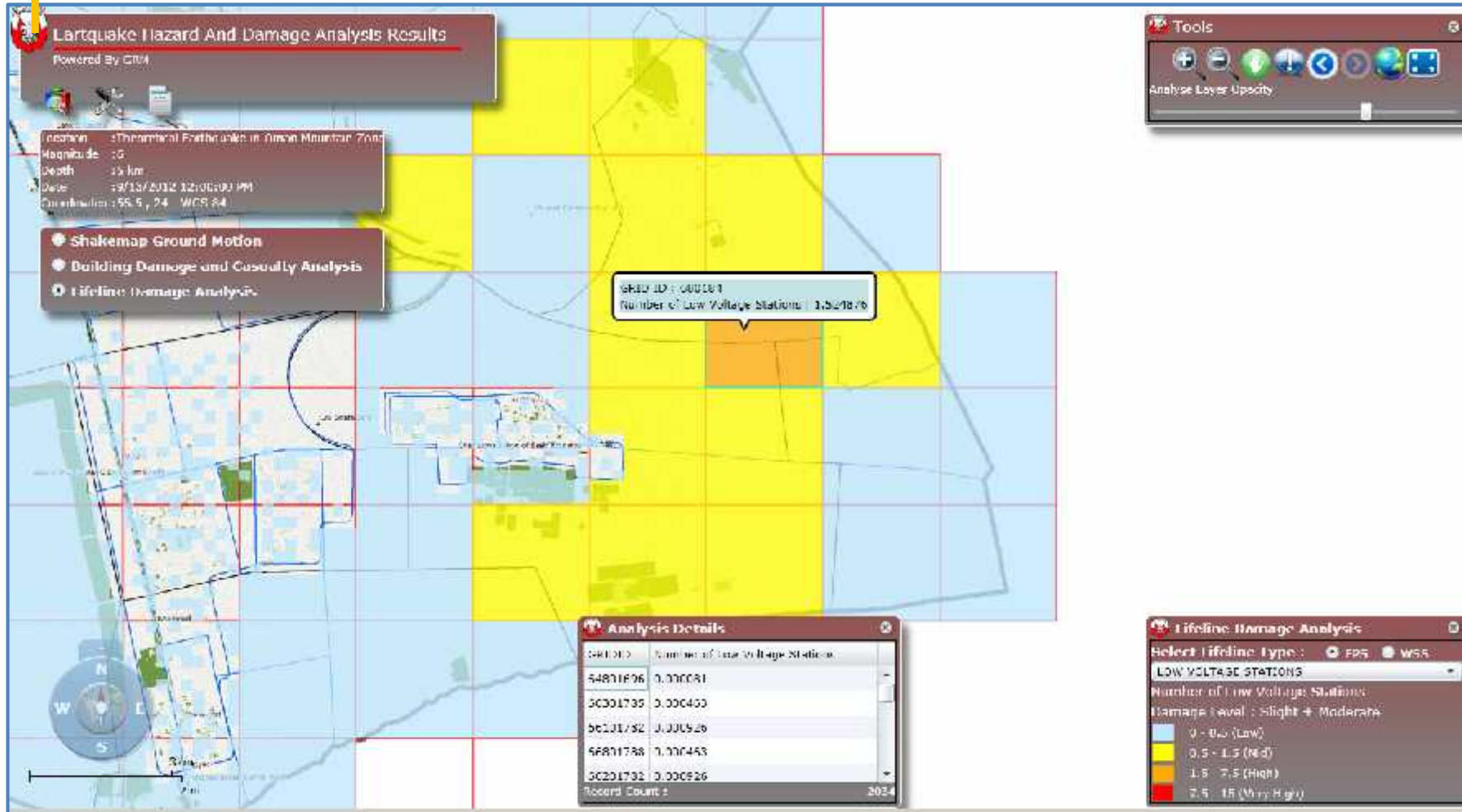
EPS Damage by Different EPS Components, Selection of the Component



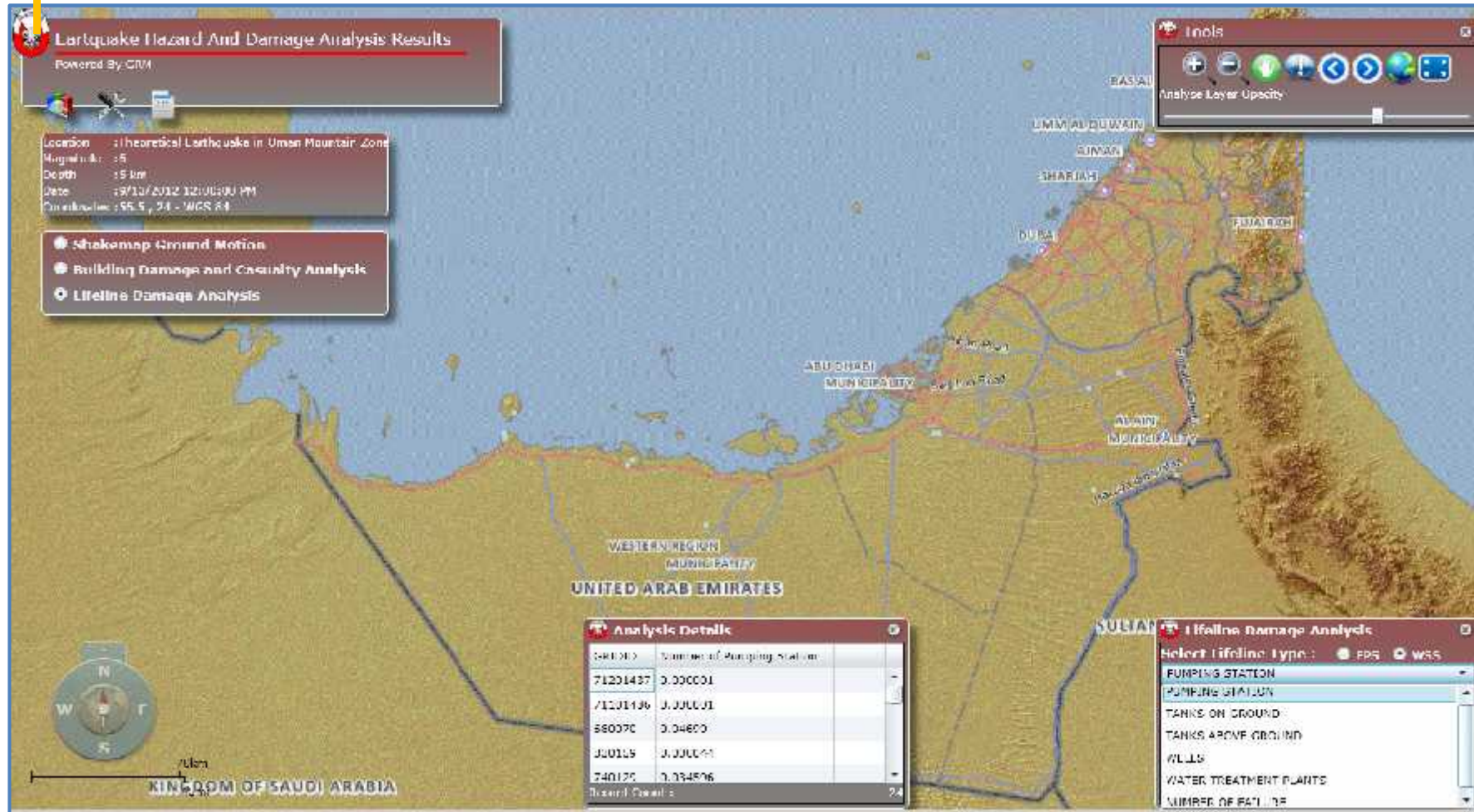
Low Voltage Stations Damage



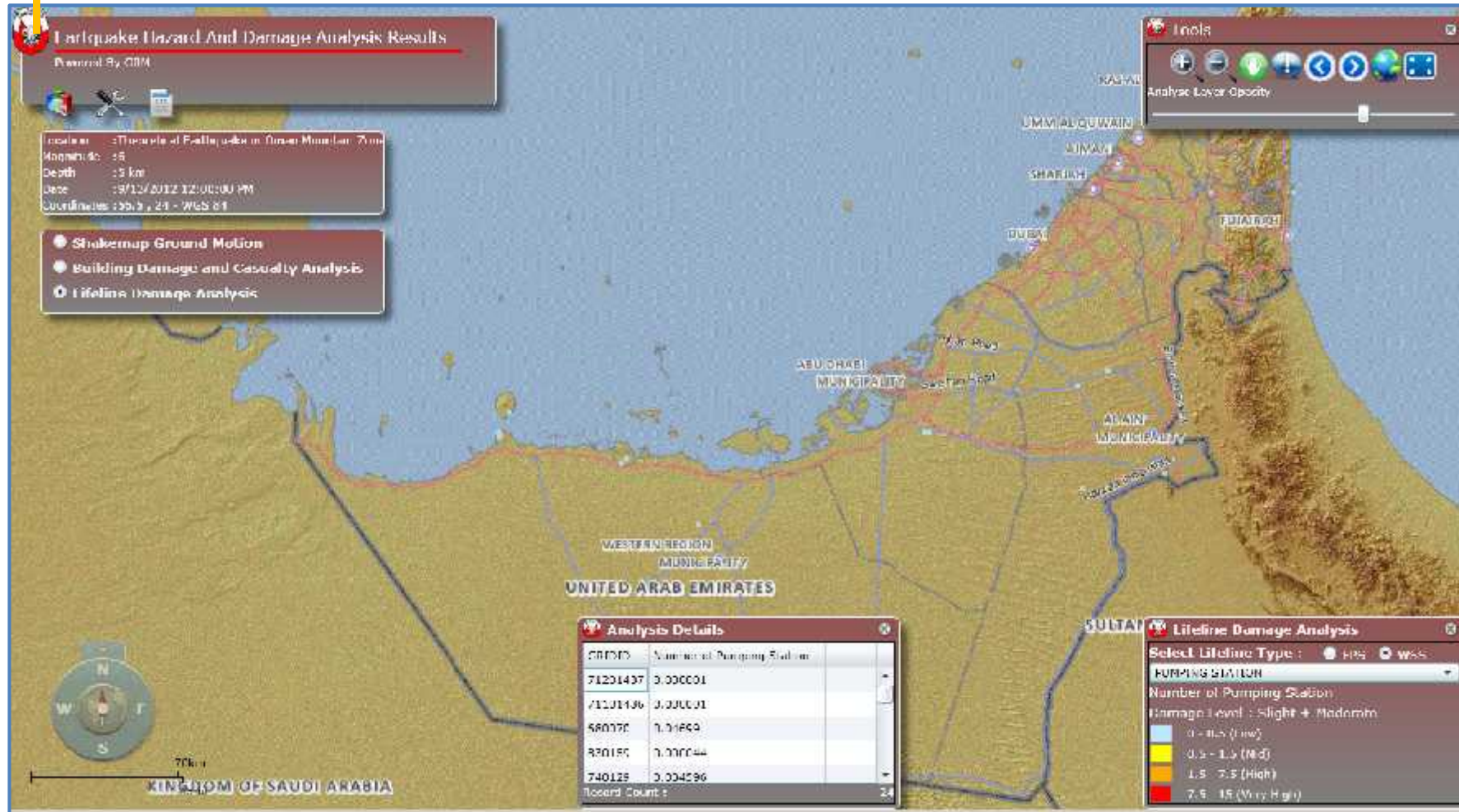
Low Voltage Stations Damage by Grid Cells



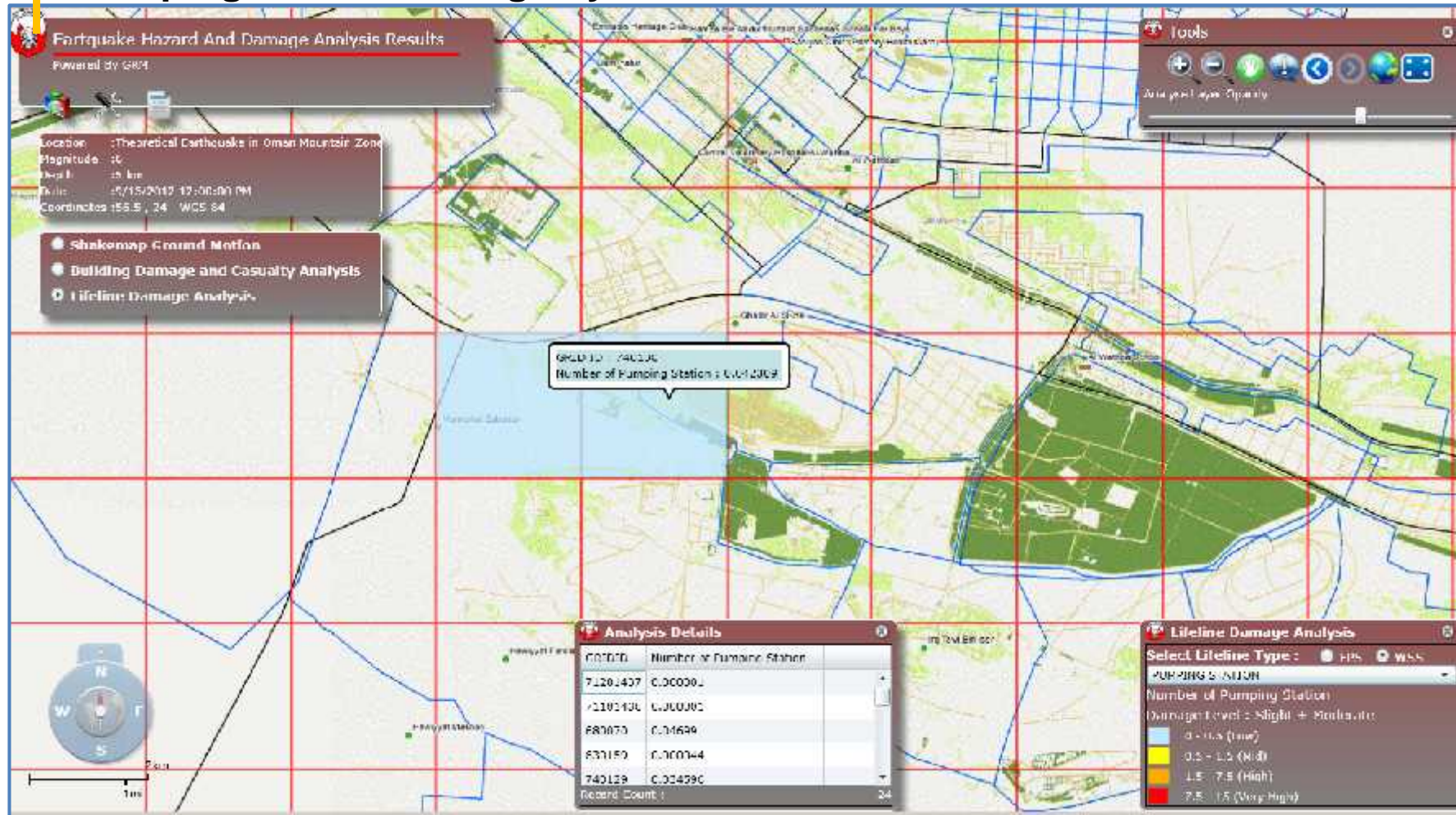
WSS Damage by Different WSS Components, Selection of the Component



Pumping Station Damage



Pumping Station Damage by Grid Cells



NRT Seismic Risk Monitoring Web: DEMO

