Probabilistic Seismic Risk Assessment for the Metropolitan Region of San Salvador (AMSS): Educational, Public Health and Governmental Agencies

Cape Town, South Africa, July 2012

Ministerio de Medio Ambiente y Recursos Naturales

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GFDRR
Global Facility for Disaster Reduction and Recovery

World Bank LAC
opportunities for all

CAPRA
Probabilistic Risk Assessment Initiative

MINED
Ministerio de Educación
Gobierno de El Salvador

Ministerio de Salud
EL SALVADOR

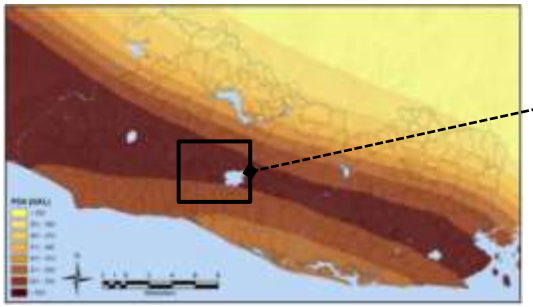
UCA

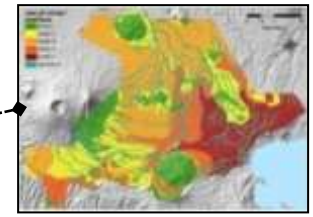
Evaluación de Riesgos Naturales
- América Latina -
Consultores en Riesgos y Desastres

ERN

Seismic Risk Assessment for the AMSS

Seismic Hazard





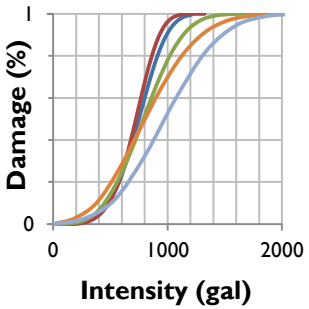
Site Effects

Regional Seismicity & Attenuation

Exposure

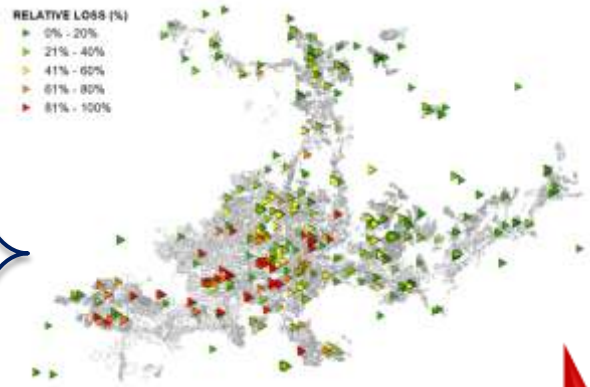
Exposure Data & Building Characteristics

Vulnerability



Expected EQ Performance

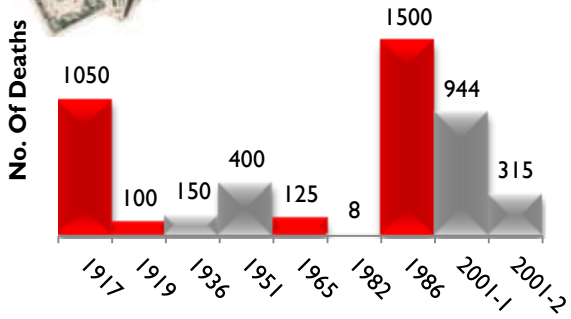
Risk Assessment



HAZARD → SCENARIO

RISK → DISASTER

Human and Economic Losses



Risk Management

- Corrective Management
- Prospective Management
- Reactive Management
- Financial Protection

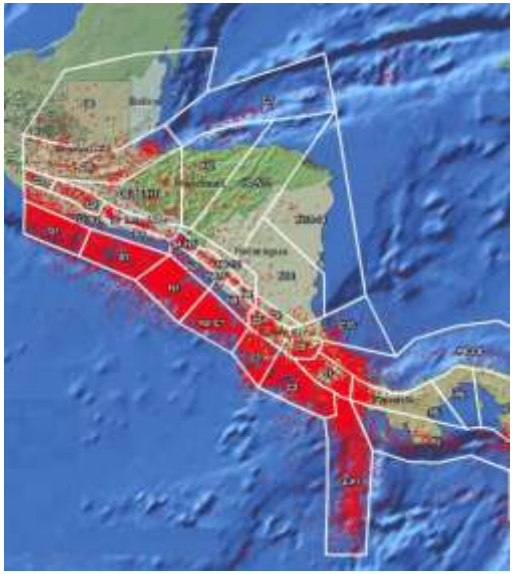
Seismic Hazard Assessment

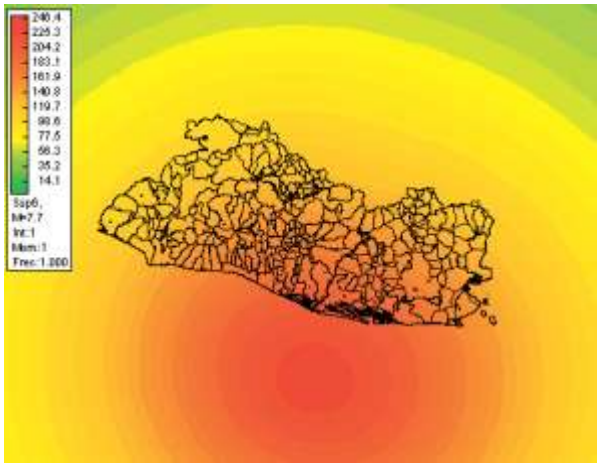
Seismic ground motion at a site depends on

SOURCE
Seismogenic source characteristics, Magnitude

ATTENUATION
Attenuation of intensity over distance

SITE EFFECTS
Amplitude and frequency content modification due to local site conditions





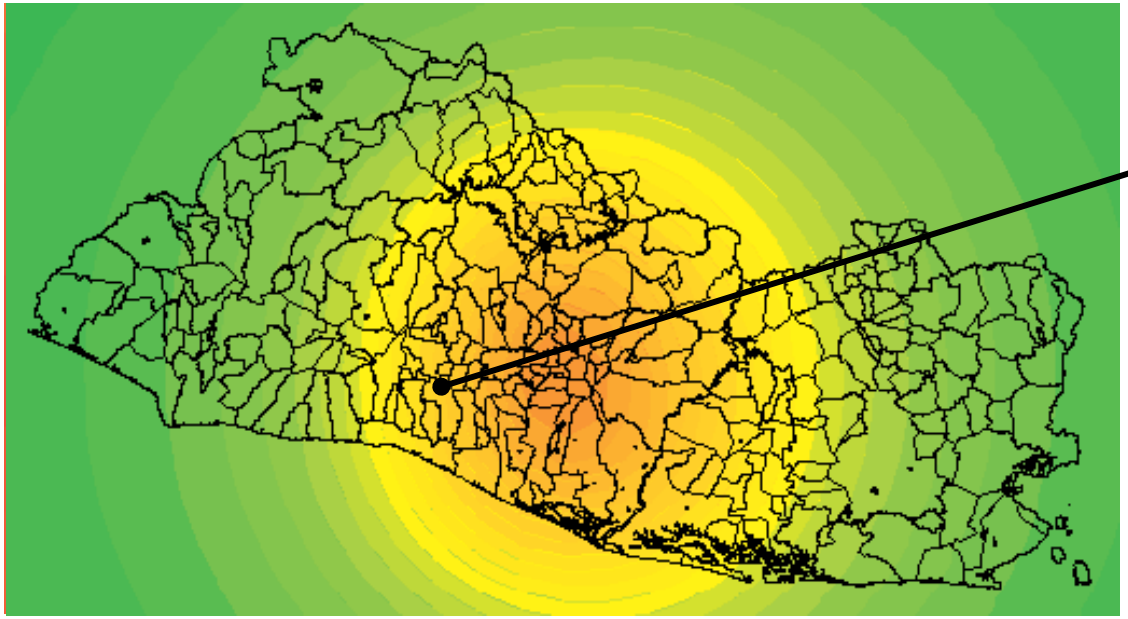
SEISMIC HAZARD MAP – NATIONAL LEVEL
On the basis of the Project RESIS II

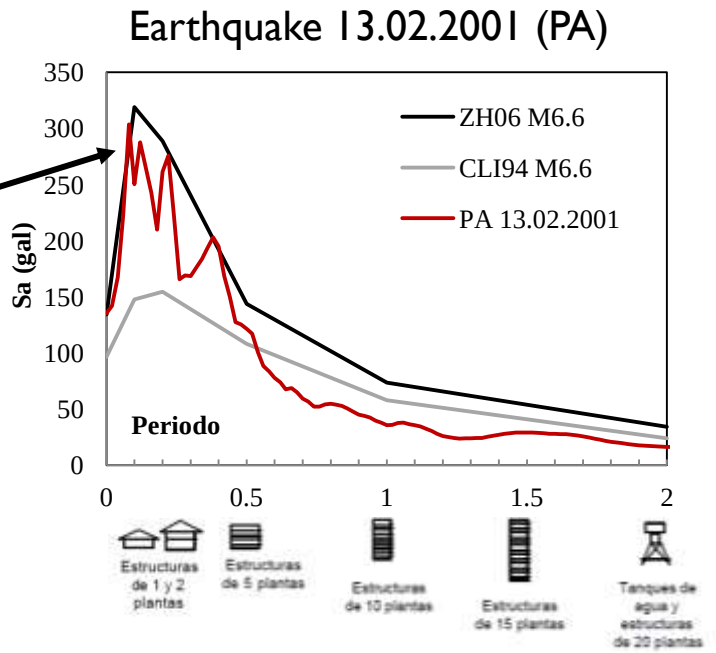
MICROZONATION (PROXI)

Seismic Hazard Assessment

Seismic Hazard – National Level

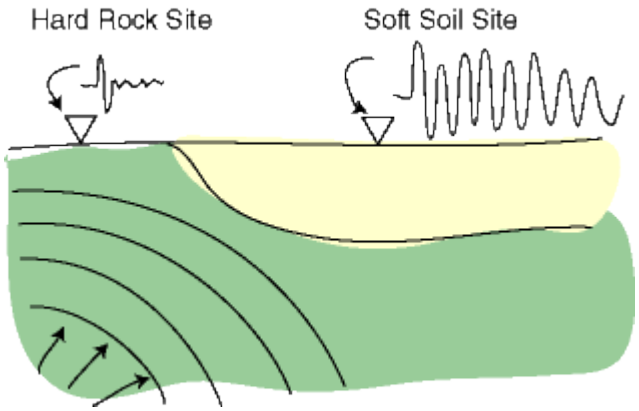
- Definition and characterization of the seismic sources (RESIS II)
- Seismicity parameters for each seismic source (RESIS II)
- Attenuation models (intensity at the site based on magnitude and distance)



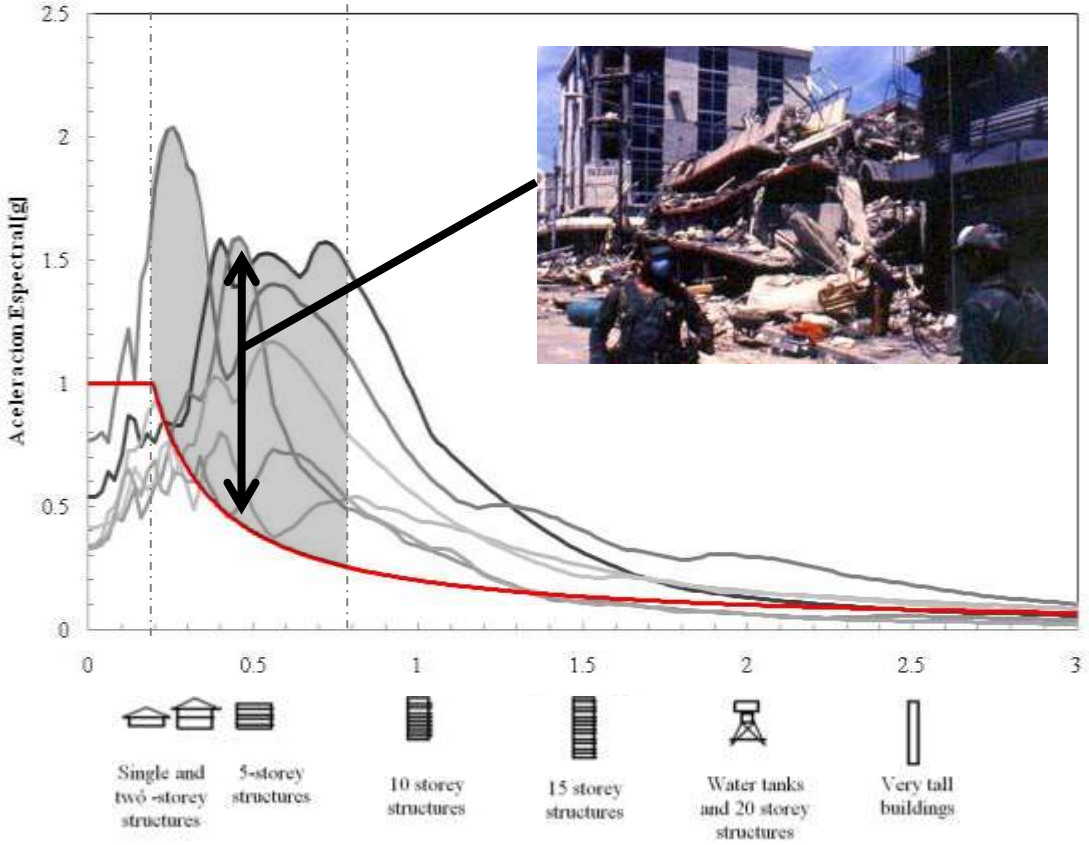


Seismic hazard map does not take into account the effects of the local site conditions (site classification "rock")

Amplification due to Site Effects

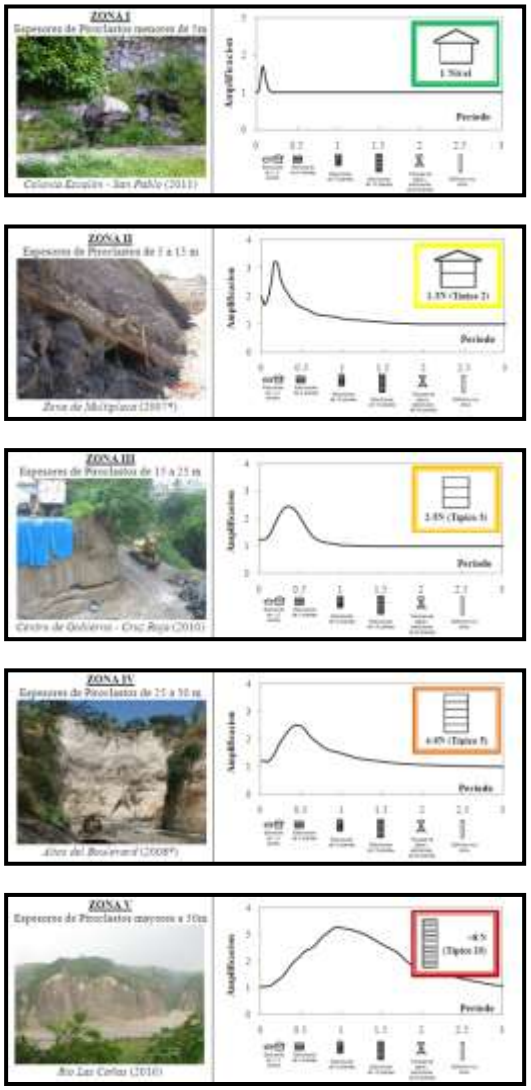


TBJ Deposits, Centro de Gobierno, S.S.



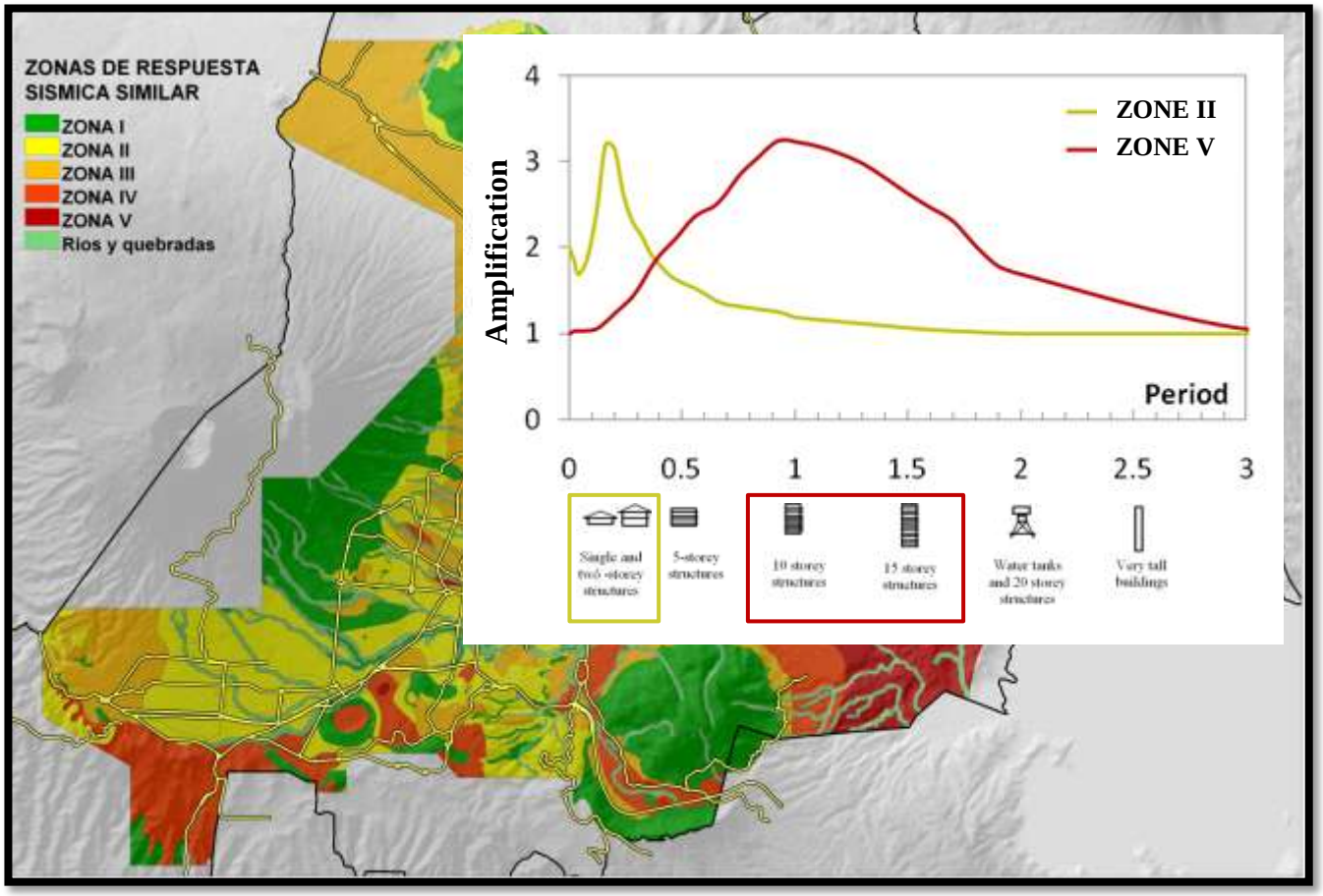
Elastic Response Spectra from the 1966, 1989 and 1994 Seismic Codes compared to the Elastic Response Spectra of the 1986 Earthquake in the East-West Direction (5% Damping)

Amplification due to Site Effects

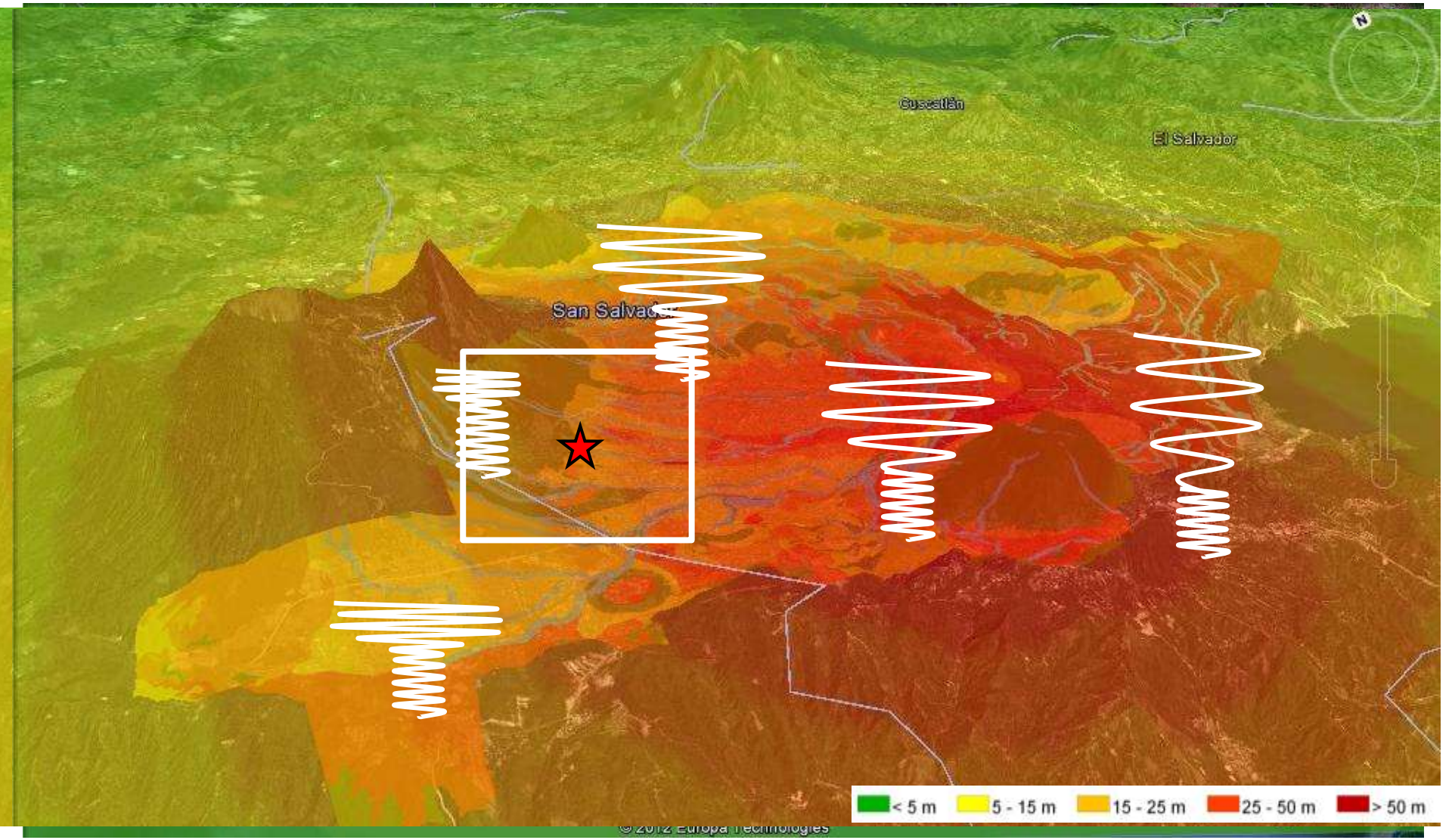


MICROZONATION MAP PROXI

DYNAMIC RESPONSE OF SOIL DEPOSITS (ELASTIC)



Seismic Hazard Assessment

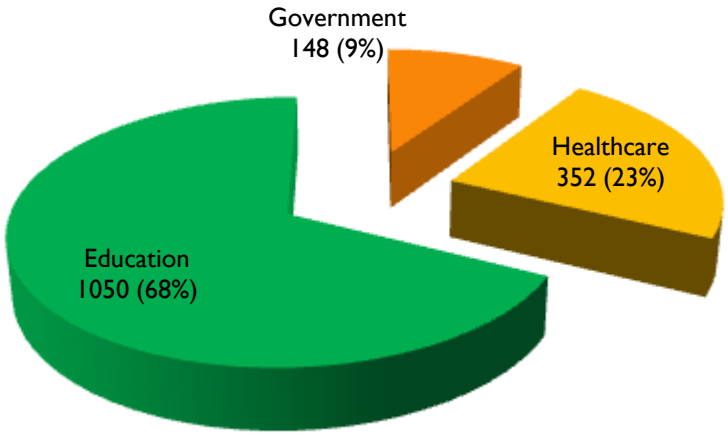


Exposure Data Gathering

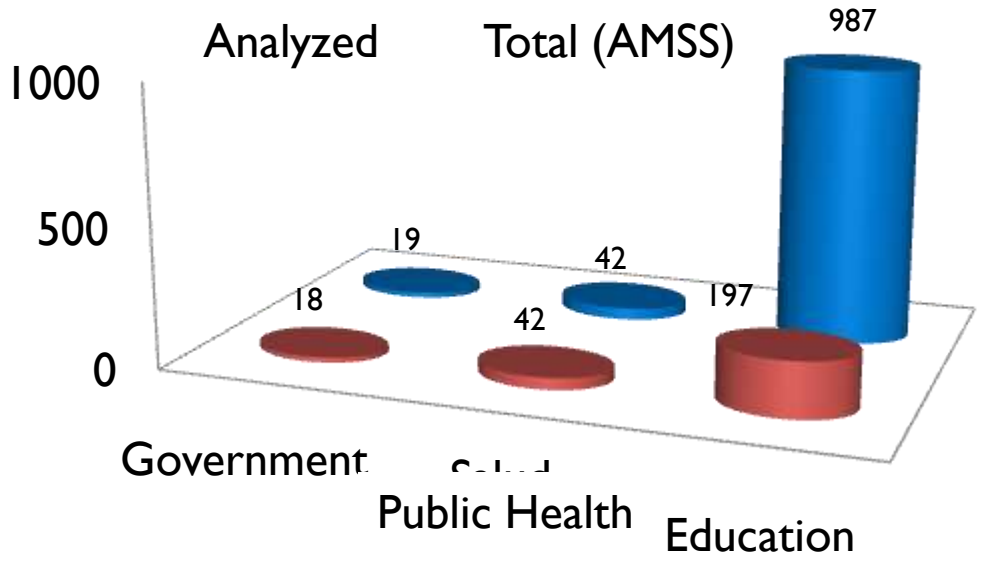
FIRST STEP: EDUCATION, PUBLIC HEALTH AND GOVERNMENT AGENCIES

Exposure Data Gathering for prioritized educational, public health and governmental institutions: geographical location, population, replacement cost, and the building characteristics considered to be strongly related to the structures capacity to resist earthquake loads (1550 buildings in 257 institutions)

Institutions



Individual Buildings



Exposure Data Gathering

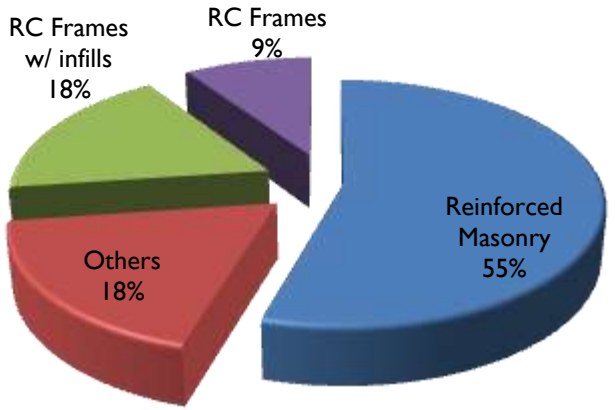
Basic Information:

Population (morning, evening, night)
Replacement Cost

Main Vulnerability Factors that Influence Earthquake Damage

Main vulnerability factors

Structural System
Level of Earthquake Resistant Design:
Construction Year (Seismic Design Code)
Fundamental Period of the Building: Height



Secondary Vulnerability Factors

Damage during previous EQ

Structural Deficiencies
- Short-Column Effect →
- Torsional Irregularity →
- Soft/Weak Story Effect →
- Flat-slab /plate Structures →
- Etc.

Exposure Data Gathering

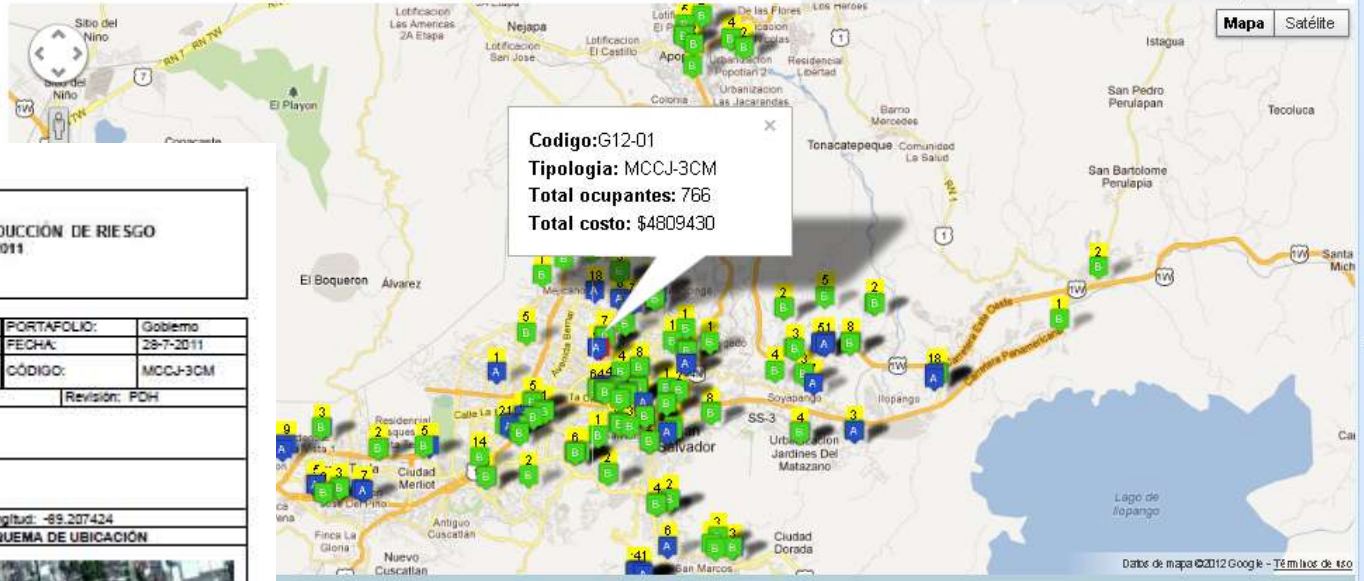
Ocultar Filtrado **Filtrado por: Todos** Cantidad ubicaciones: 248

Educación | Salud | Gobierno | Todos los portafolios

Sistema | Tipología

Filtrar las ubicaciones por los siguientes sistemas estructurales:

Marcos de concreto con arriostramiento diagonal
Marcos de concreto sin arriostramiento diagonal
Marcos de concreto con paredes de relleno con junta



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PROGRAMA NACIONAL DE REDUCCIÓN DE RIESGO
CONTRATO MARN/PNRR No. 067/2011

PORTAFOLIOS DE EDUCACIÓN, SALUD Y GOBIERNO		PORTAFOLIO:	Gobierno
FORMATO DE CARACTERIZACIÓN DE ESTRUCTURAS		FECHA:	28-7-2011
MARCOS DE CONCRETO SIN JUNTA DE DILATACIÓN, ALTOS, CÓDIGO MEDIANO		CÓDIGO:	MCCJ-3CM
Inspección: RAAA	Rev. Inspección: NEAL	Proceso: GHPO	Revisión: PDH

Código Institución: G12-1 | Nombre: Ministerio de Hacienda

Dirección: Bulevar de los Héroes No 1231

Municipio: San Salvador | Coordenadas: Latitud: 13.712933 Longitud: -89.207424

FACHADA

ESQUEMA DE UBICACIÓN

CARACTERÍSTICAS GENERALES		SISTEMA ESTRUCTURAL	DEFECTOS ESTRUCTURALES
Uso:	Oficinas	Dirección paralela fachada (x): marcos de concreto con paredes de relleno con junta	☐ Columna corta ☐ Irregularidad en planta ☐ Irregularidad torsional ☐ Piso flexible o débil ☐ Entrepiso sin vigas ☐ Paredes esbeltas y sin amarre ☐ Irregularidad en elevación ☑ Sobrepeso en el edificio ☐ Golpeteo ☐ Columna débil, viga fuerte ☐ Baja calidad en materiales
Año de construcción:	1997		
Número de pisos:	7		
Altura típica entrepisos:	2.7 m		
Área de construcción:	6925.0 m²		
Estructura de techo:	☐ Rígido: ☑ Flexible con viga amarre ☐ Flexible sin viga amarre	Dirección perpendicular fachada (y): marcos de concreto con paredes de relleno sin junta	
Daños en sismos anteriores:	☐ 1986 ☑ 2001	Observaciones: Sótano confinado únicamente en el sector oriente del edificio. La cubierta de techo de escaleras y ascensor es losa densa. Existe sobrepeso en los niveles 1 y 2 por biblioteca y archiveros, respectivamente.	
No ocupantes: Mañana:	383		
Tarde:	383		
Noche:	0		

VALOR DE REPOSICIÓN	
Edificación:	$4071900
Mob. y equipo:	$737530

Leyenda y Etiquetas

Ver leyenda inicial
quitar/mostrar etiquetas

l de la estructura:

A	B	C
1 piso	2-5 pisos	6 pisos

de construción:

menores a 1965	entre 1965-1988	mayores 1988

de construción:

menor a 500	entre 500-2000	mayor a 2000

pantes:

menor a 50	entre 50-200	mayor a 200

to:

menor a	entre	mayor a

"PROGRAMA NACIONAL DE REDUCCIÓN DE RIESGO"

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Generar CSV

Exposure Data Gathering

Lack of planning and haphazard growth

Mixture of construction materials with different seismic performance (lack of continuity and homogeneity) – Structural Deficiencies

Difficulties in exposure data gathering – extraordinary amount of buildings per institution

Precarious Systems (3.7%)

1 Institution- 59 different buildings (71 total)

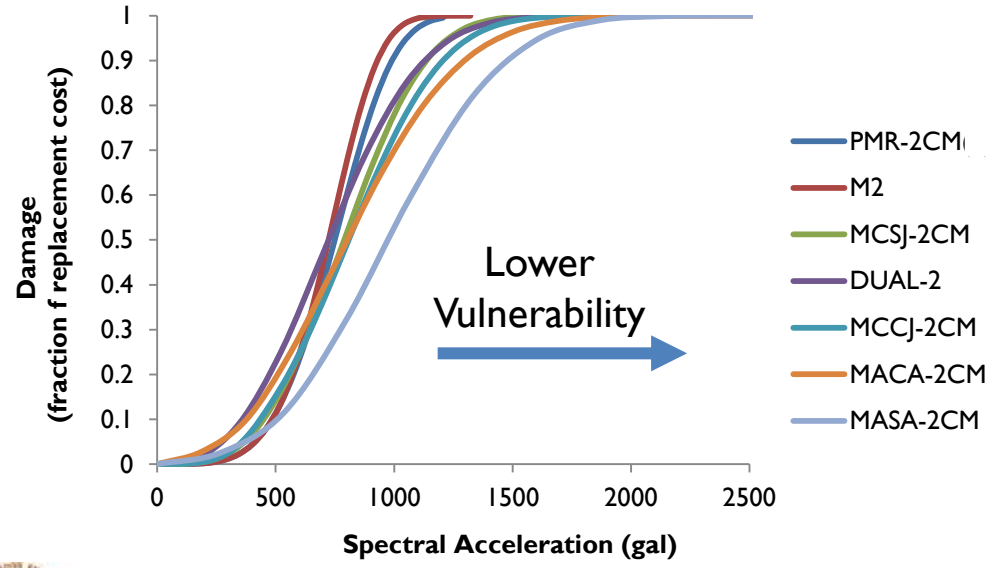
Vulnerability Assessment

Vulnerability Curves

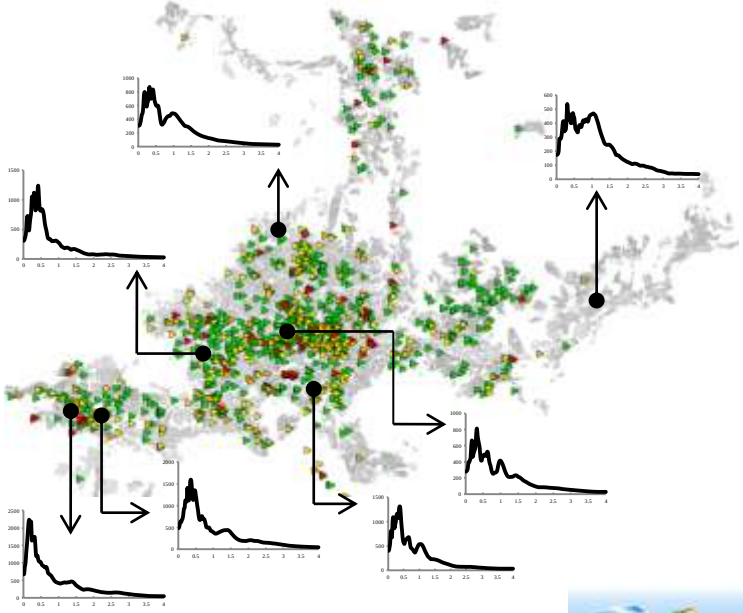
Analytical Models

Experimental data (Taishin)

Definition of Vulnerability Curves

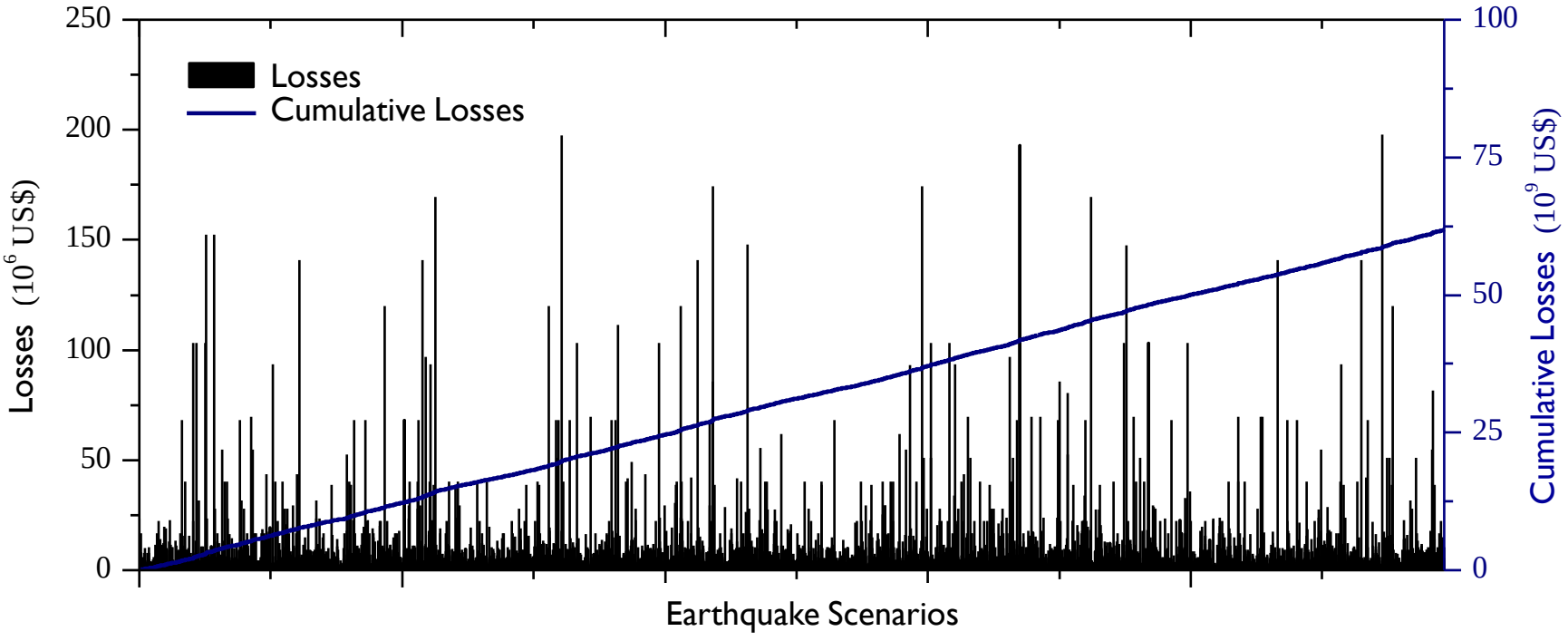


Calibration - observed damage



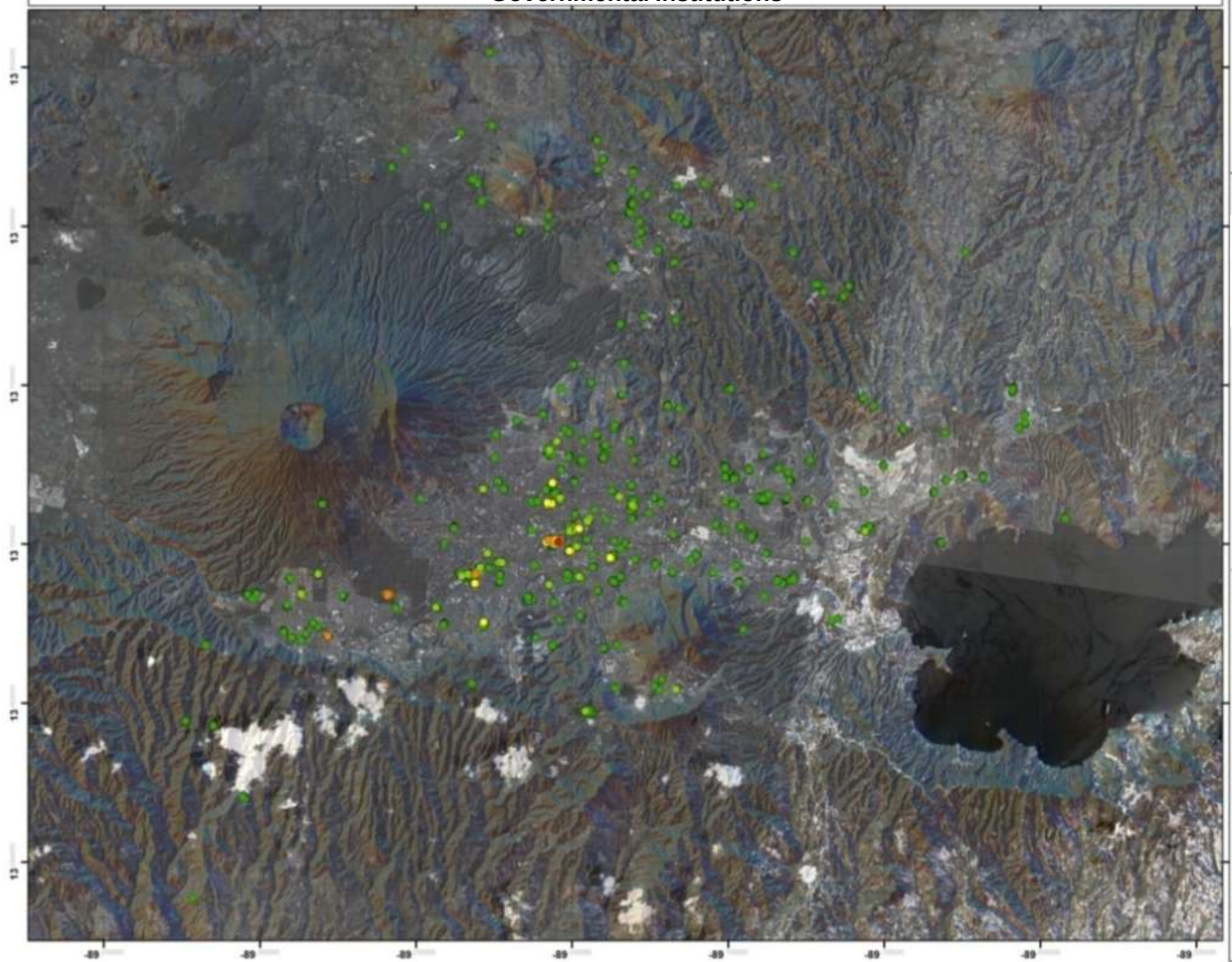
Probabilistic Risk Assessment

Considering the contribution of all seismic scenarios and their probability of occurrence, an annualized los on the order of USD$14.7 Millions, was estimated to cover only 257 institutions, 5.78% of the total exposed value.



Seismic Risk Assessment for the RMSS

Probabilistic modeling of Seismic Risk Scenarios for the AMSS, Educational, Public Health and Governmental Institutions



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LEGEND

Probabilistic Analysis
Annualized loss
(1000 US)

- 0 - 26
- 27 - 109
- 110 - 242
- 243 - 423
- 424 - 1475

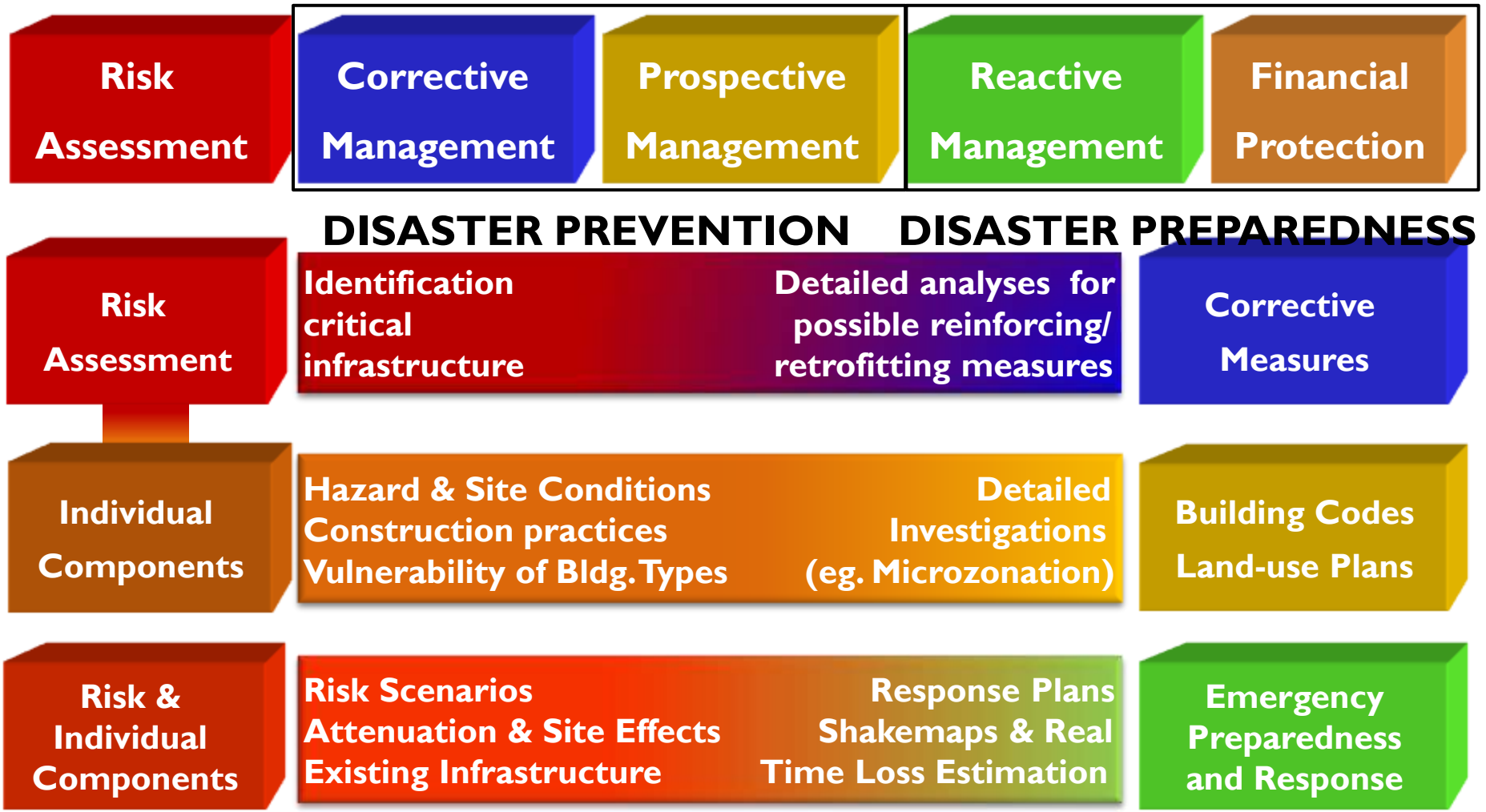
Referencia

Sistema de Coordenadas WGS 84
(Sistema Geodésico Mundial 1984)

0 2.5 5 10
Kilometros

Risk Management

Risk Assessment to provide decision-making tools for risk reduction



Risk Reduction Measures

	Measure	Ongoing Research	Future Work Needed
HAZARD AND RISK ASSESSMENT	Instrumentation for Data generation. Hazard and Risk Assessment Studies	Improvement of the Seismic Network (PNRR, 2012; JICA, 2014) Site effect investigation (AMSS) PROXI for evaluation of seismic site conditions and amplifications at a national level (PGA) Strong motion data base, consultation and graphic representation of SM parameters	Complete seismic risk assessment for remaining AMSS educational institutions Risk assessment of major cities. Instrumentation of Important Buildings (vulnerability assessment and structural health monitoring) Constant updated of Hazard Studies **MICROZONATION of the RMSS**
CORRECTIVE & PROSPECTIVE MGMT	Seismic Risk reduction (reduce current and future vulnerability)	Seismic Hazard and Risk assessment for the AMSS, educational, public health and governmental agencies – Presentation and publication of results, investment plans for prioritized critical infrastructure.	Land Use planning considering seismic hazard (Microzonation) Seismic code revision and update (MOP) Public awareness program Improve construction practices Structural reinforcing/strengthening of strategic infrastructure (portfolios)

Risk Reduction Measures

	Measure	Ongoing Research	Future Work Needed
REACTIVE MANAGEMENT	Emergency response: identifying most affected areas to guide assistance	Update of the seismic monitoring center with a new software for seismic data acquisition, data exchange and automatic processing of EQ recordings (preliminary locations and magnitudes) Improvement of the Seismic Network (PNRR, 2012; JICA, 2014). Including real time strong motion data Correlation of instrumental seismic intensity with strong motion parameters Shake Maps in terms of PGA (real time strong motion records + models)	Shake Maps (real time strong motion records + models) for different spectral ordinates. Response plans using specific scenarios (DGPC) (exposure and vulnerability data of major cities) Near real time damage and loss estimations for emergency response (exposure and vulnerability data of major cities)

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