Ongoing and future seismological and geophysical investigations in Venezuela, and an application to Seismic Microzoning Projects

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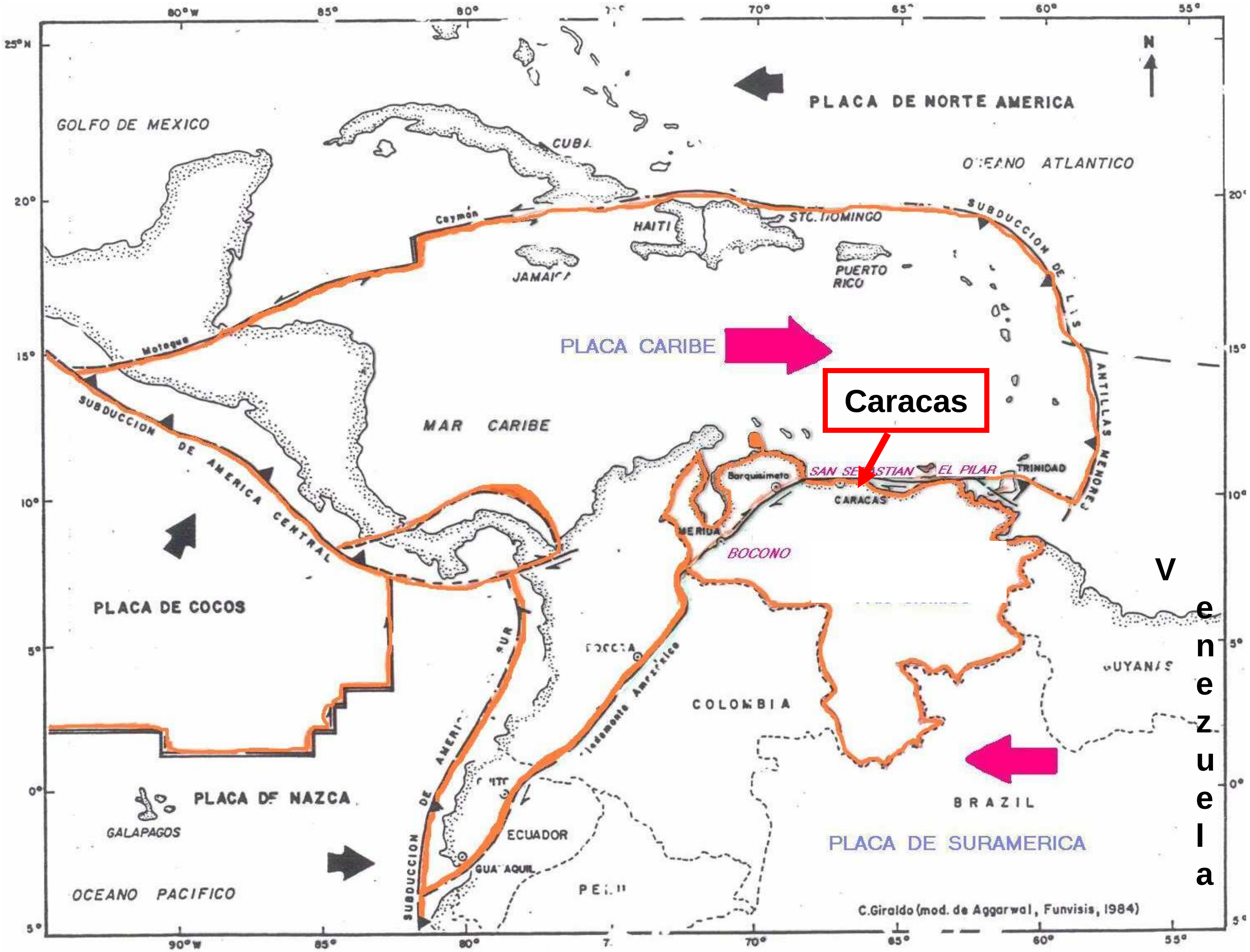
Venezuelan Foundation for Seismological Research
FUNVISIS

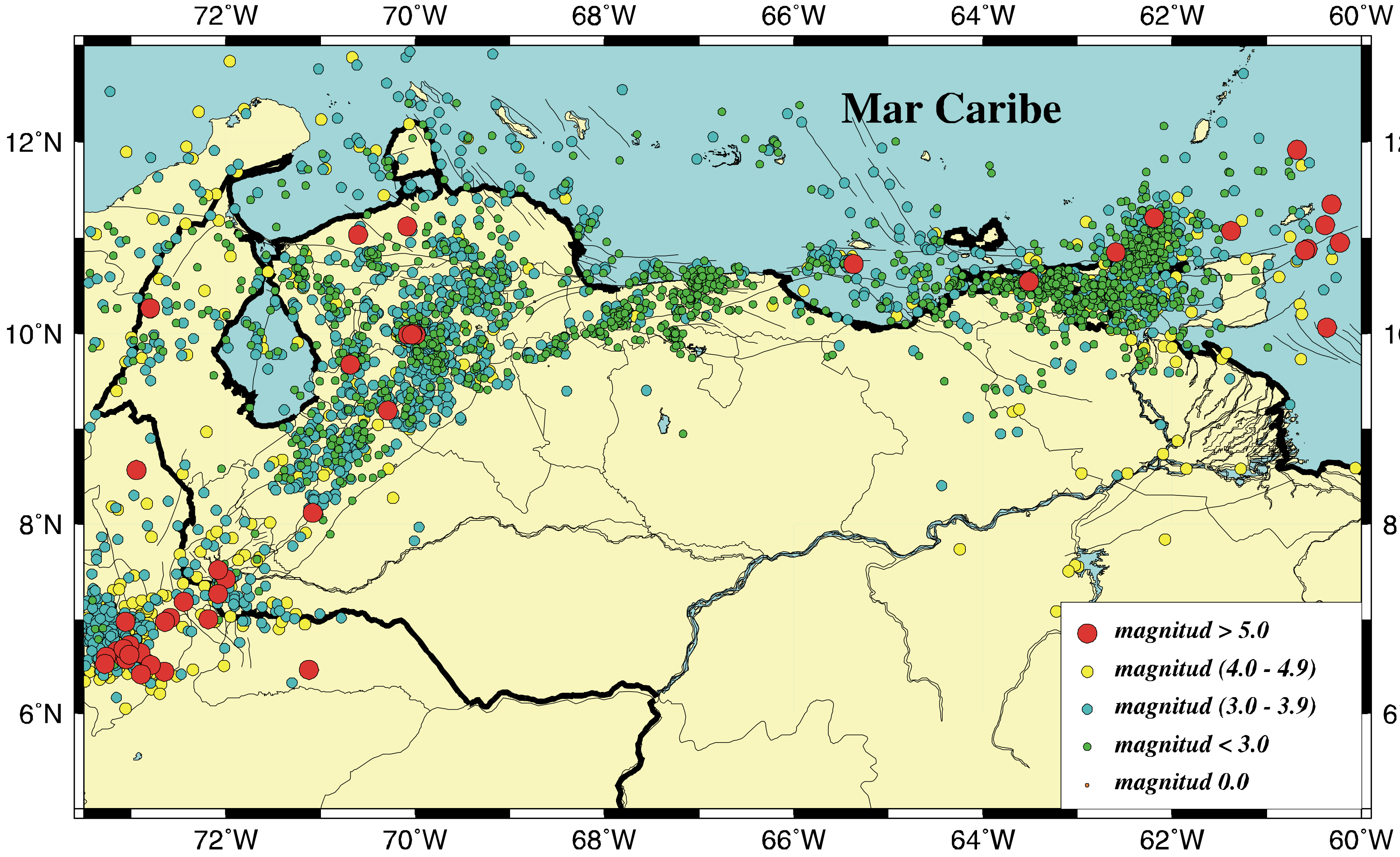
Workshop on Geophysical Hazard and Plate Boundary Processes in Central America, Mexico and the Caribbean
Heredia, Costa Rica, October 24-27, 2010

Motivation

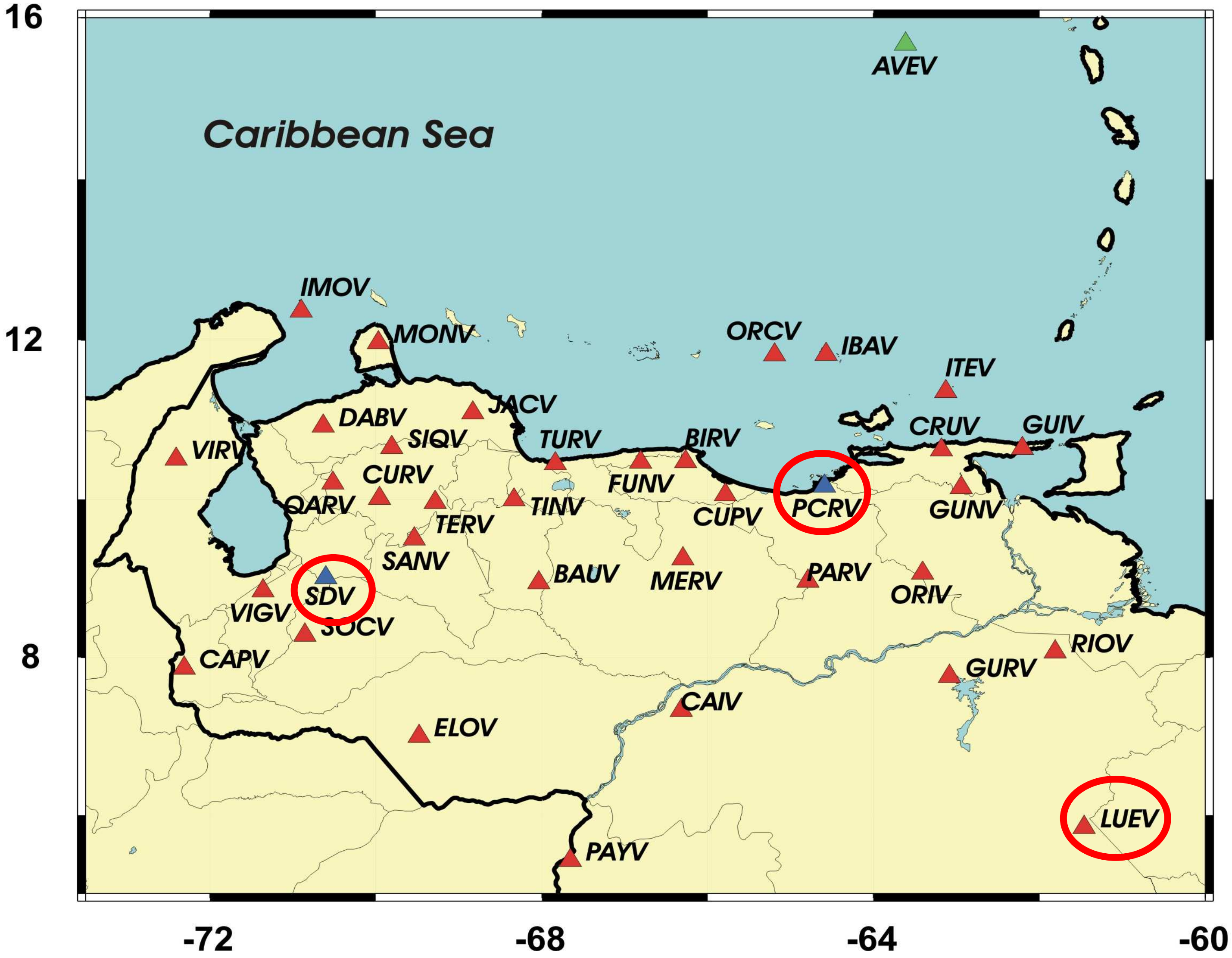


High seismic hazard at Caribbean – South America plate boundary zone

Seismicity in Venezuela 2000-2010



Venezuelan National Seismological Network



35 BB Seismic Stations equipped with Guralp sensor and digitizer (CMG-40T)

2 VBB Seismic Stations within the CTBTO umbrella, they are **AS117** (IRIS station with Streickessen sensor) and **AS118** (35 m Borehole station with GURALP sensor).

National network operated by FUNVISIS (governmental agency)

Station characteristics

- Vaultwithreinforced concrete
- Concrete basement 1 mtdeep toenhanceoptimum couplingsensor- ground.

- Broad-bandsensorGuralp CMG-40T
- Three (3) components.
- 24 bits digitizer.
- Flat velocity response in therange (0.03 – 50.) hz.

Some stations…

TEREPAIMA, EDO. LARA

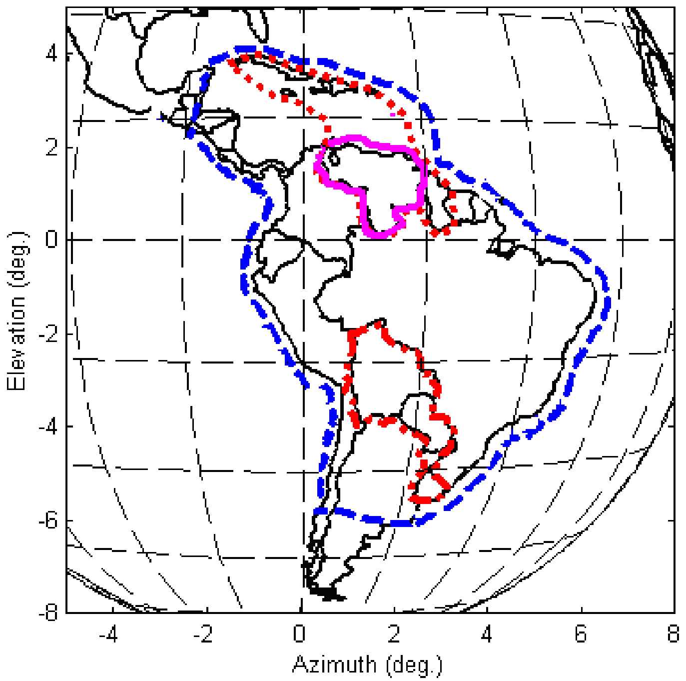
LOS MONJES

BIRONGO, EDO. MIRANDA

JACURA, EDO. FALCÓN

GUANOCO, EDO. SUCRE

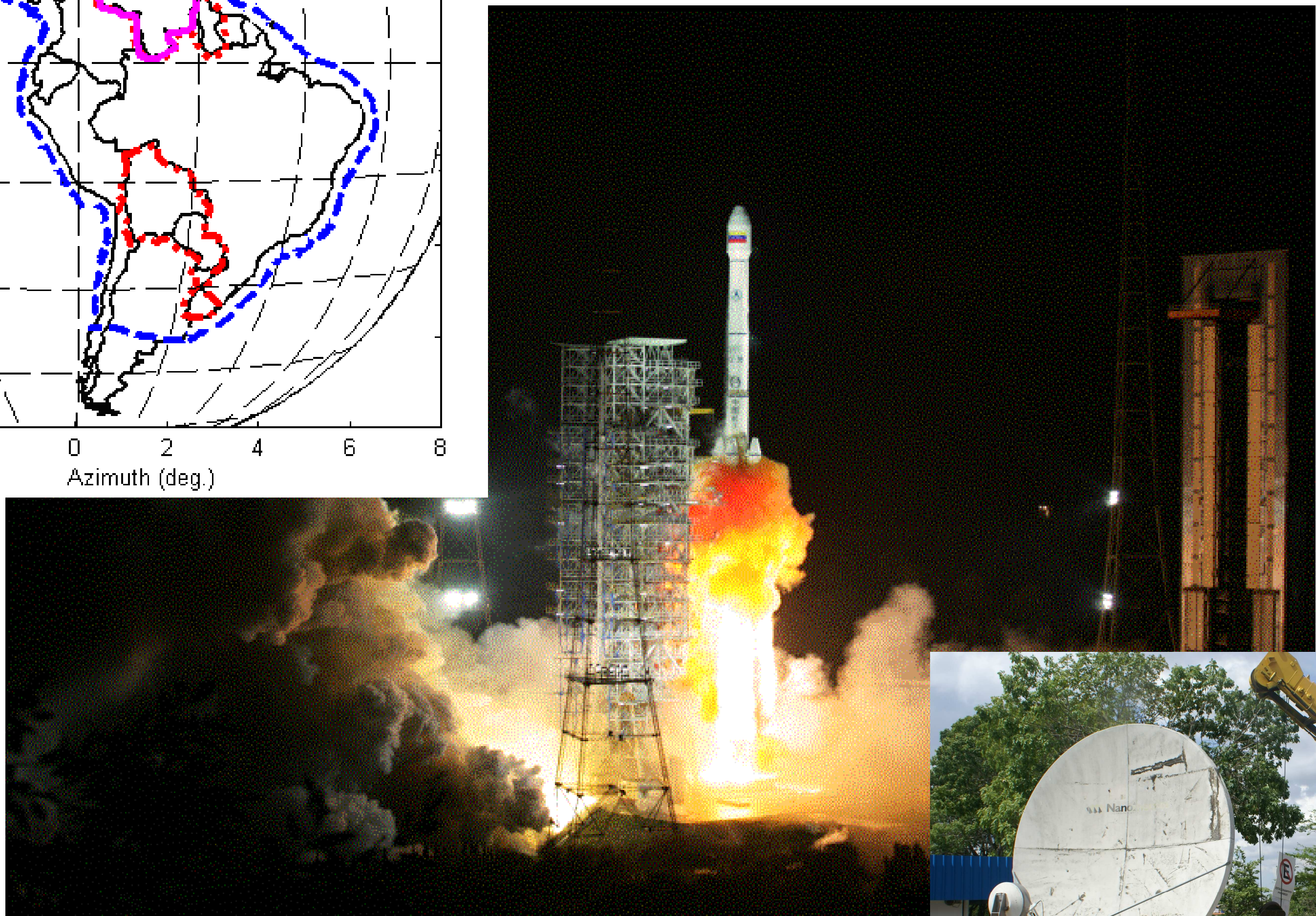
Change to venezuelan communication satellite



Blue: C-band

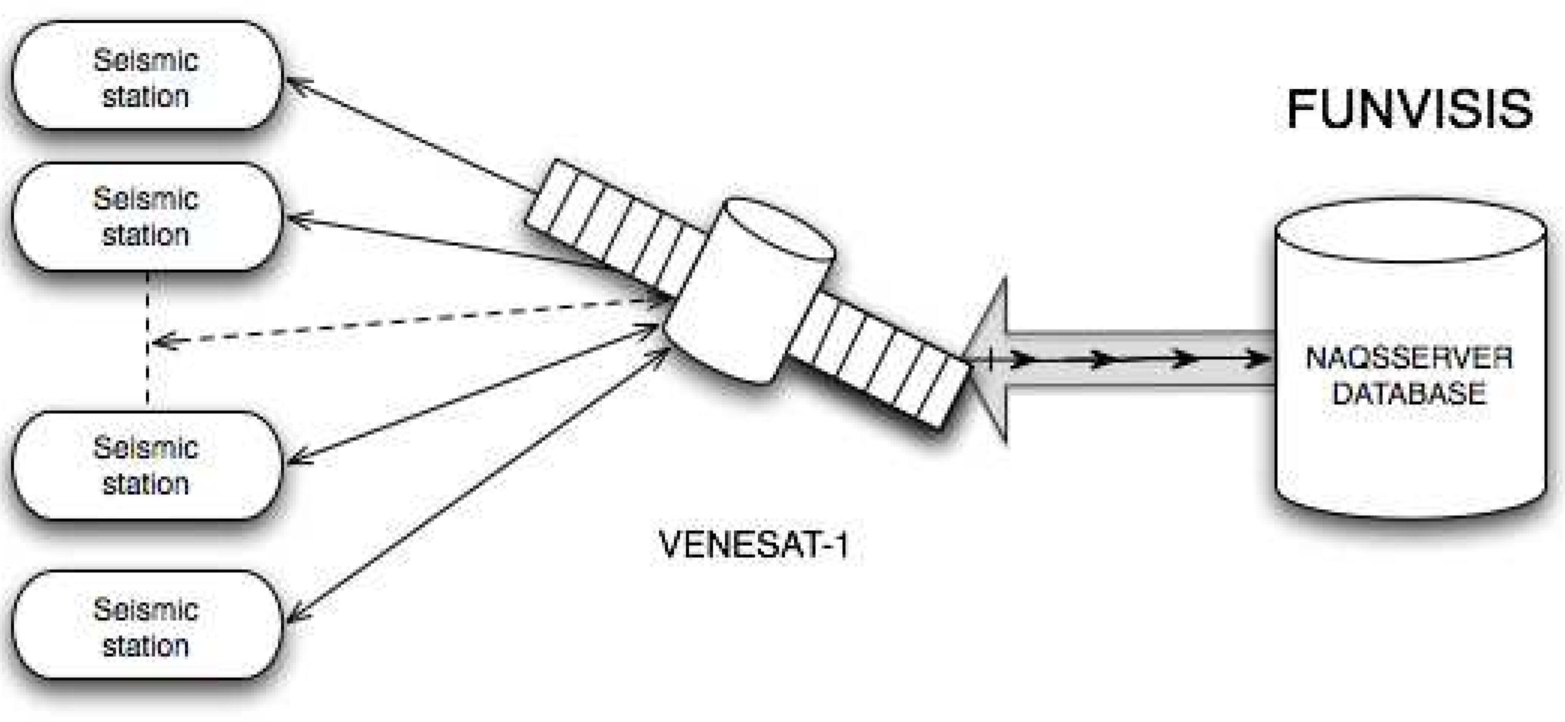
Red: Ku-band

Pink: Ka-band



Migration from INTELSAT IS-703 to satellite Simón Bolívar (SSB) in 2009: 80% of stations

SATELITE DATAFLOW

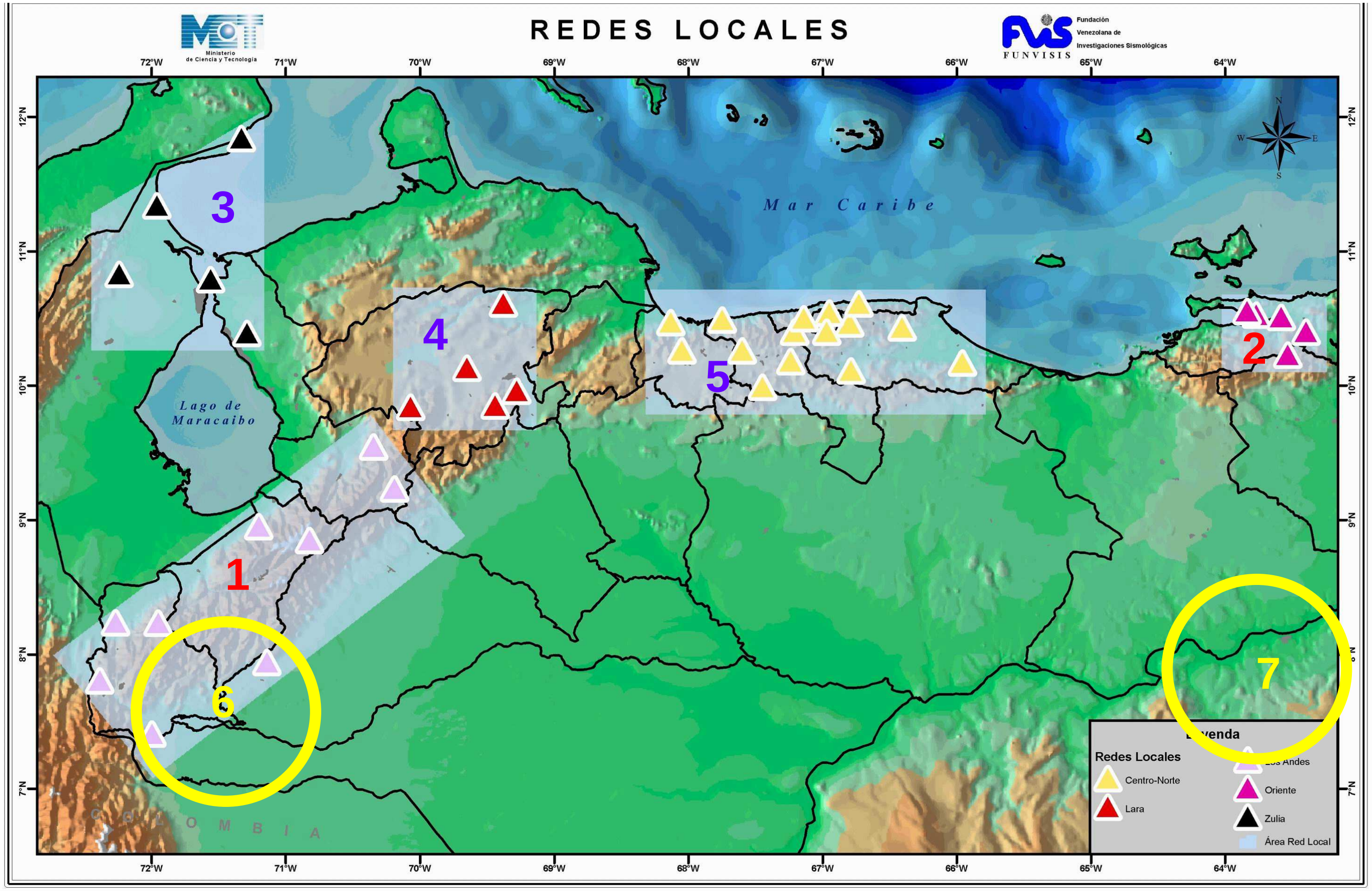


3 Channel
BroadBand
100 sps
24bit

Ku Band
10 Segment available for this network (5 in use)

1 main server
& 2 backup server

Short Period Seismic Stations (local networks)



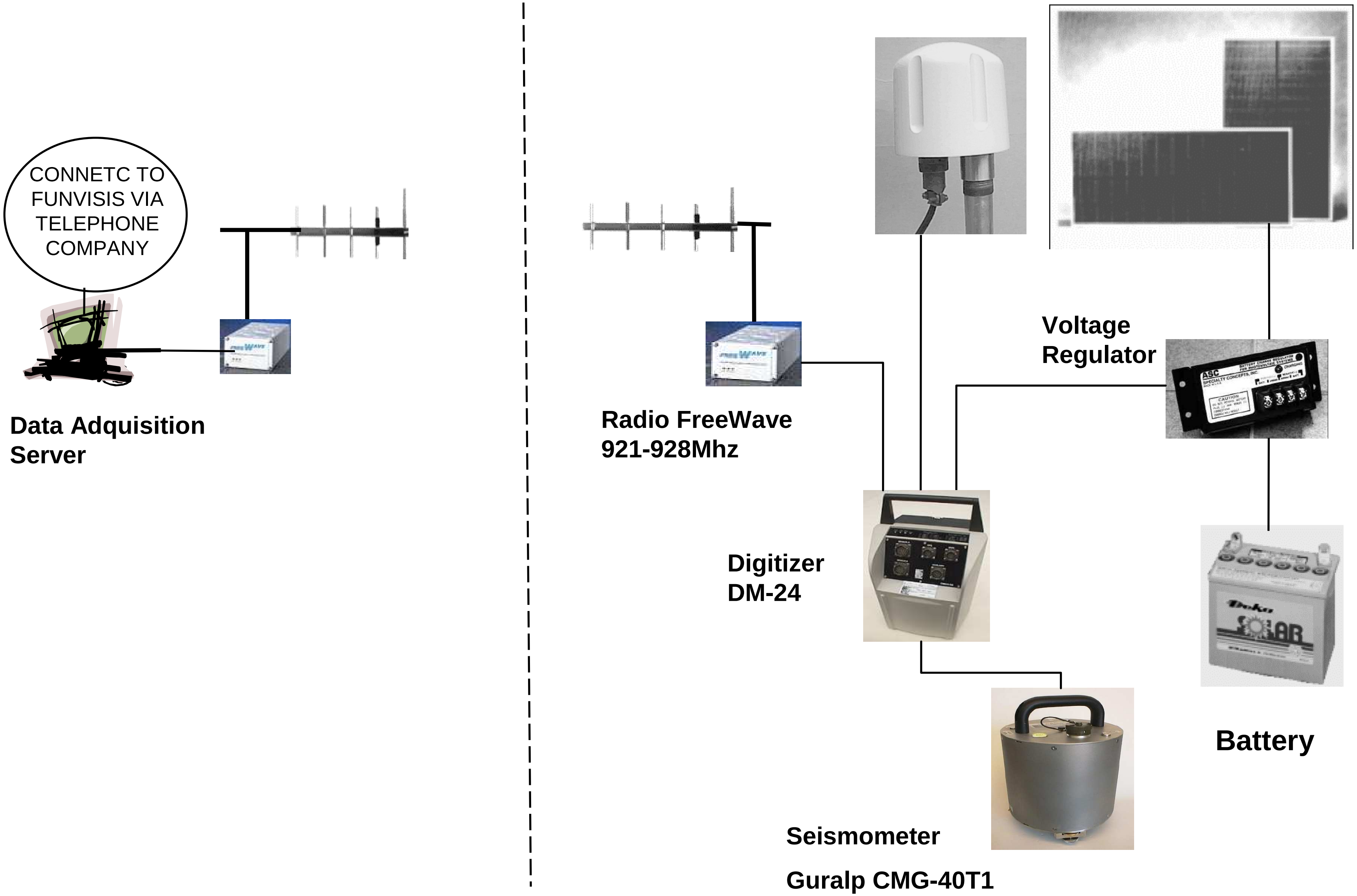
40 short period seismic stations grouped en **5** local networks. Stations are equipped with the CMG-40T1.

Networks operated by local universities in cooperation with FUNVISIS: 1) Universidad de Los Andes (ULA), 2) Universidad de Oriente (UDO)

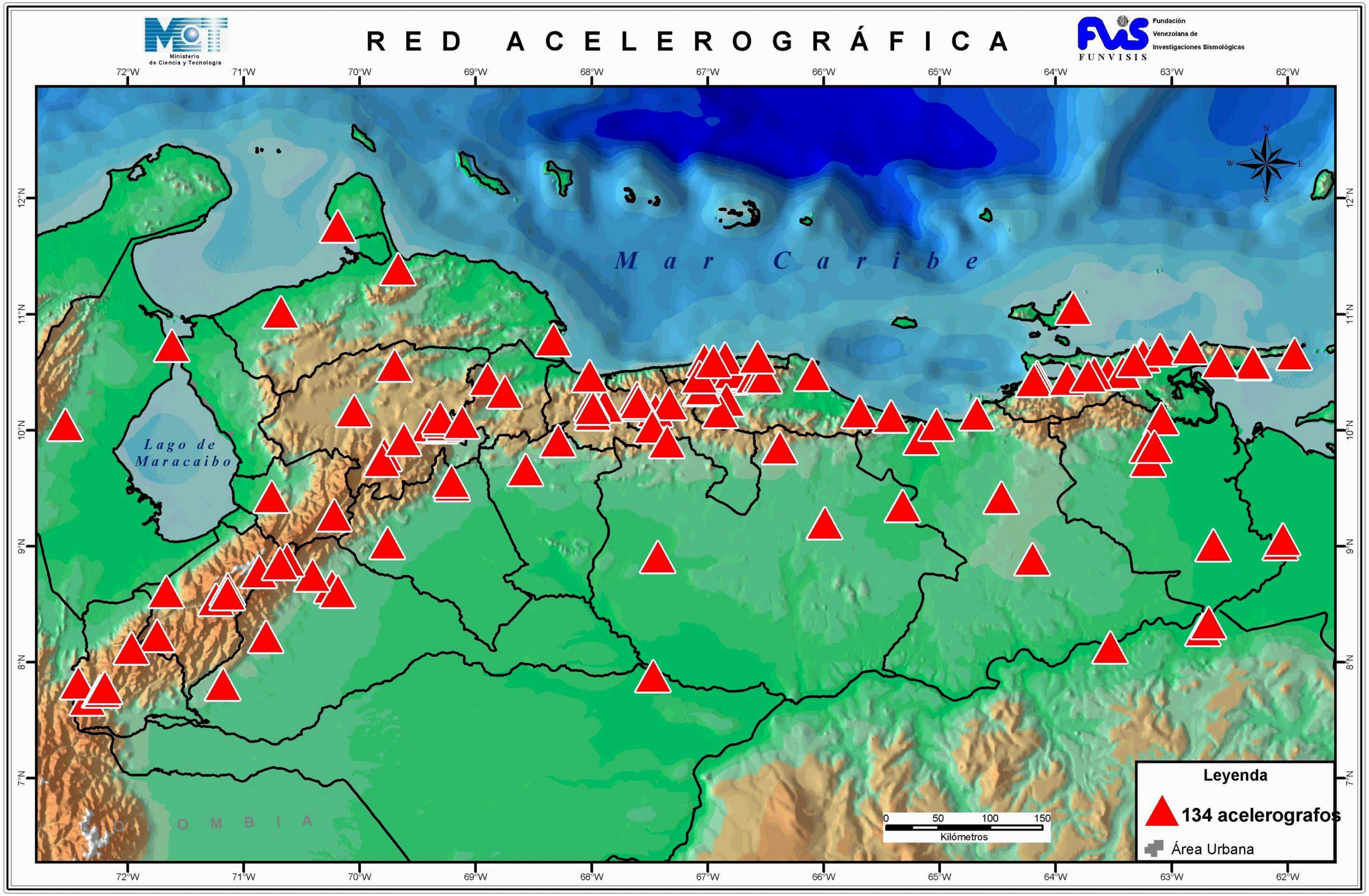
Networks operated by FUNVISIS in cooperation with local universities: 3) LUZ, 4) UCLA, 5) U-Carabobo

Local networks related to hydroelectric dams: 6) DESURCA, 7) EDELCA

Configuration of local network stations



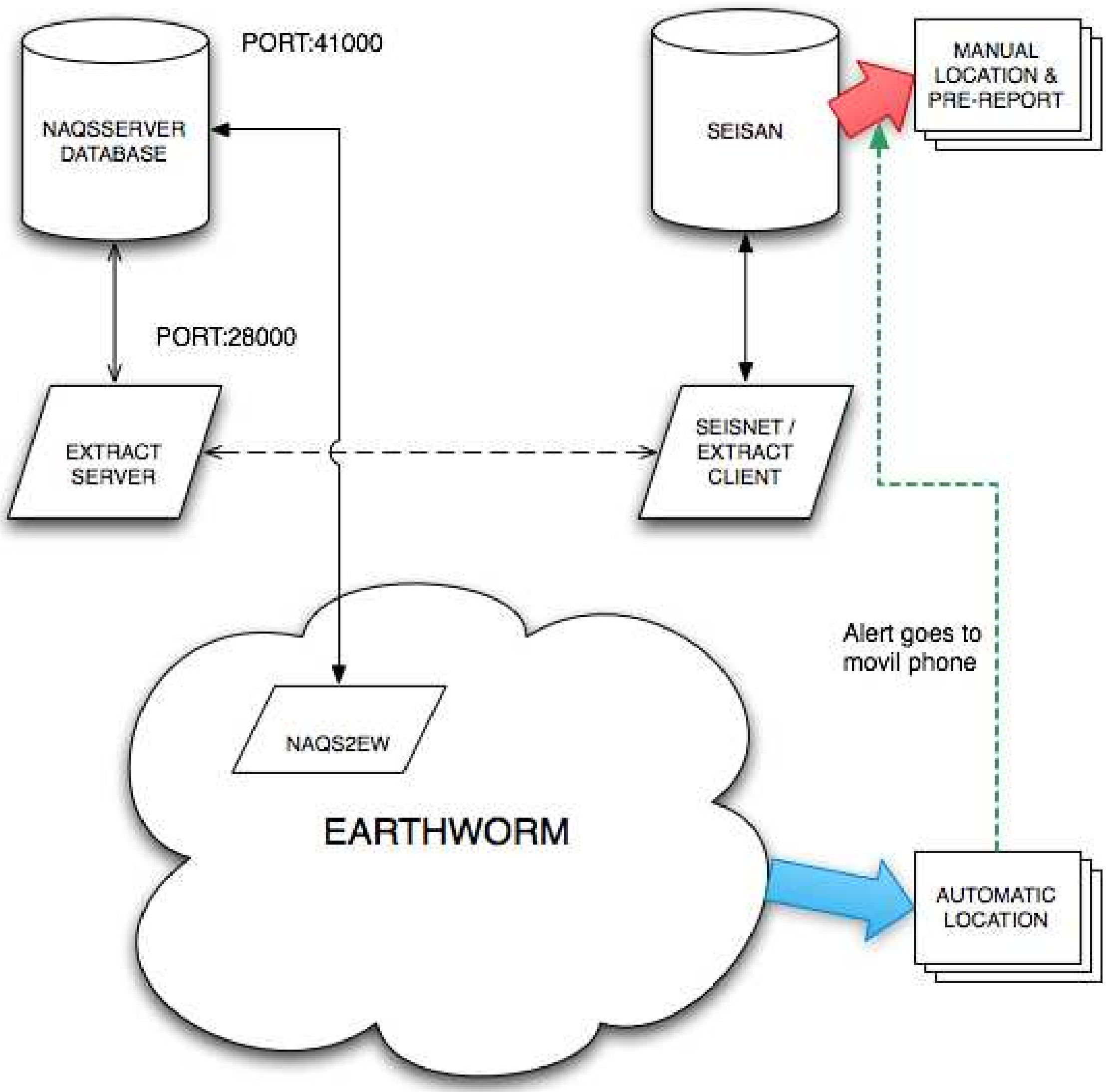
Strong motion network



Typical strong motion station

140 Accelemetric Stations with Etna from Kinemetrics

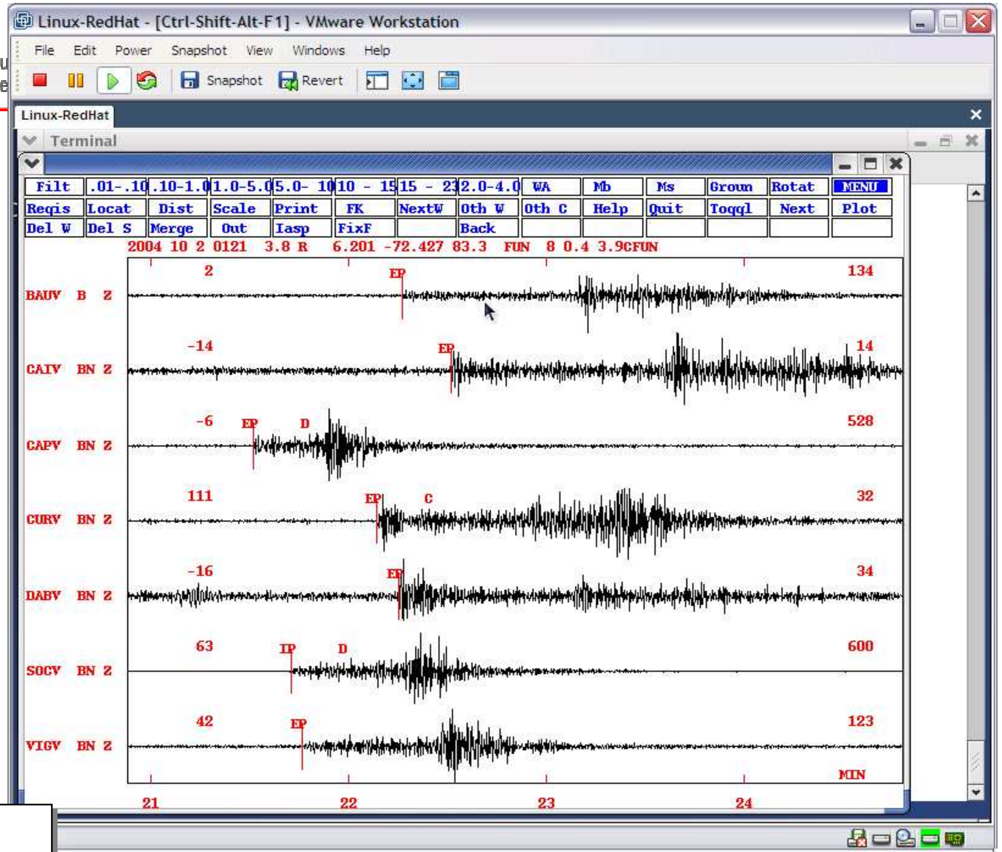
Seismic event data flow

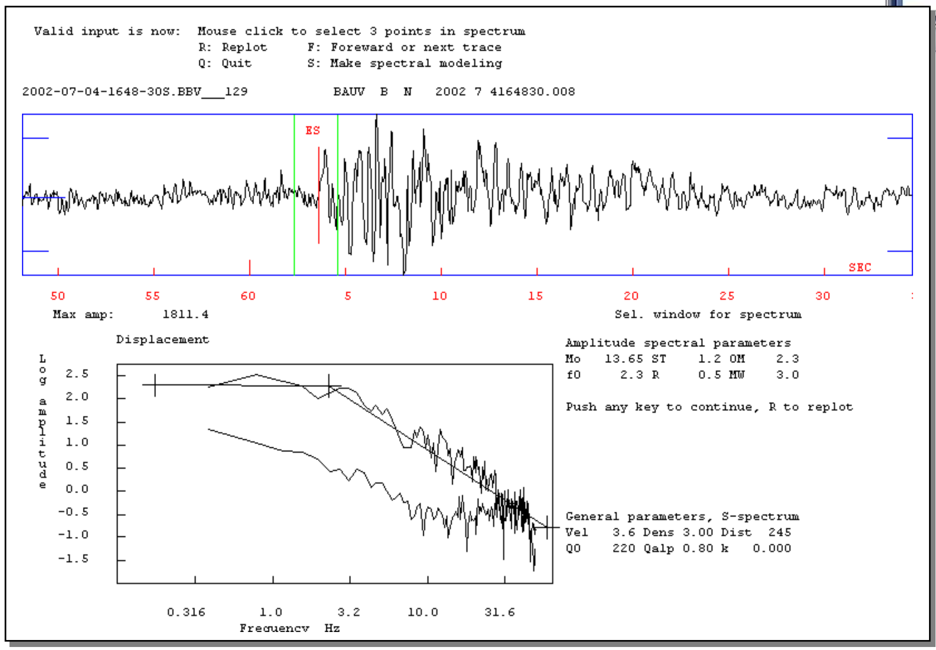


The HYPOCENTER routine within the SEISAN package is used to produce seismic event location.

The Seismic Database is maintained within the structure that SEISAN offers for waveforms the calculated events (S-files) and the Seismic Catalog.

Data request from the Database is done with the tools that SEISAN offers.





In a routine basis, magnitude is computed using Mw, and focal mechanism are determined for the bigger events using polarity of the first arrival.

Gobierno Bolivariano de Venezuela | Ministerio del Poder Popular para Ciencia, Tecnología e Industrias Intermed

The Seismological Service has an analyst in the Data Center at FUNVISIS 24 hours a day, everyday.

A weekly seismologist is on call, and a SMS message generated by the automatic location given by EARTHWORM reaches its cell-phone.

A report is posted on the WEB site and distributed to officials.

FUNVISIS President responsible for handling the media

Gobierno Bolivariano de Venezuela | Ministerio del Poder Popular para Ciencia y Tecnología | Fundación Venezolana de Investigaciones Sismológicas

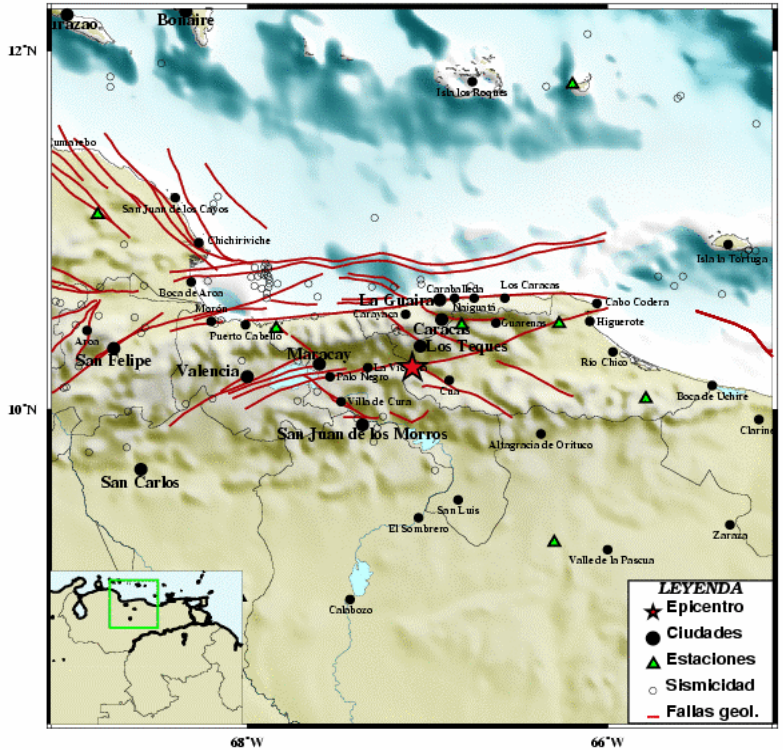
FUNVISIS

G-20007752-2

SERVICIO SISMOLÓGICO NACIONAL

REPORTE SISMOLÓGICO PRELIMINAR

FECHA (HLV): 4/ 5/2009	TIEMPO ORIGEN (HLV): 4:40:19.7
FECHA (UTC): 4/ 5/2009	TIEMPO ORIGEN (UTC): 9:10:19.7
LATITUD (grados N): 10.23	LONGITUD (grados W): 67.08
MAGNITUD (Mw): 5.4	PROFUNDIDAD (km): 3.4



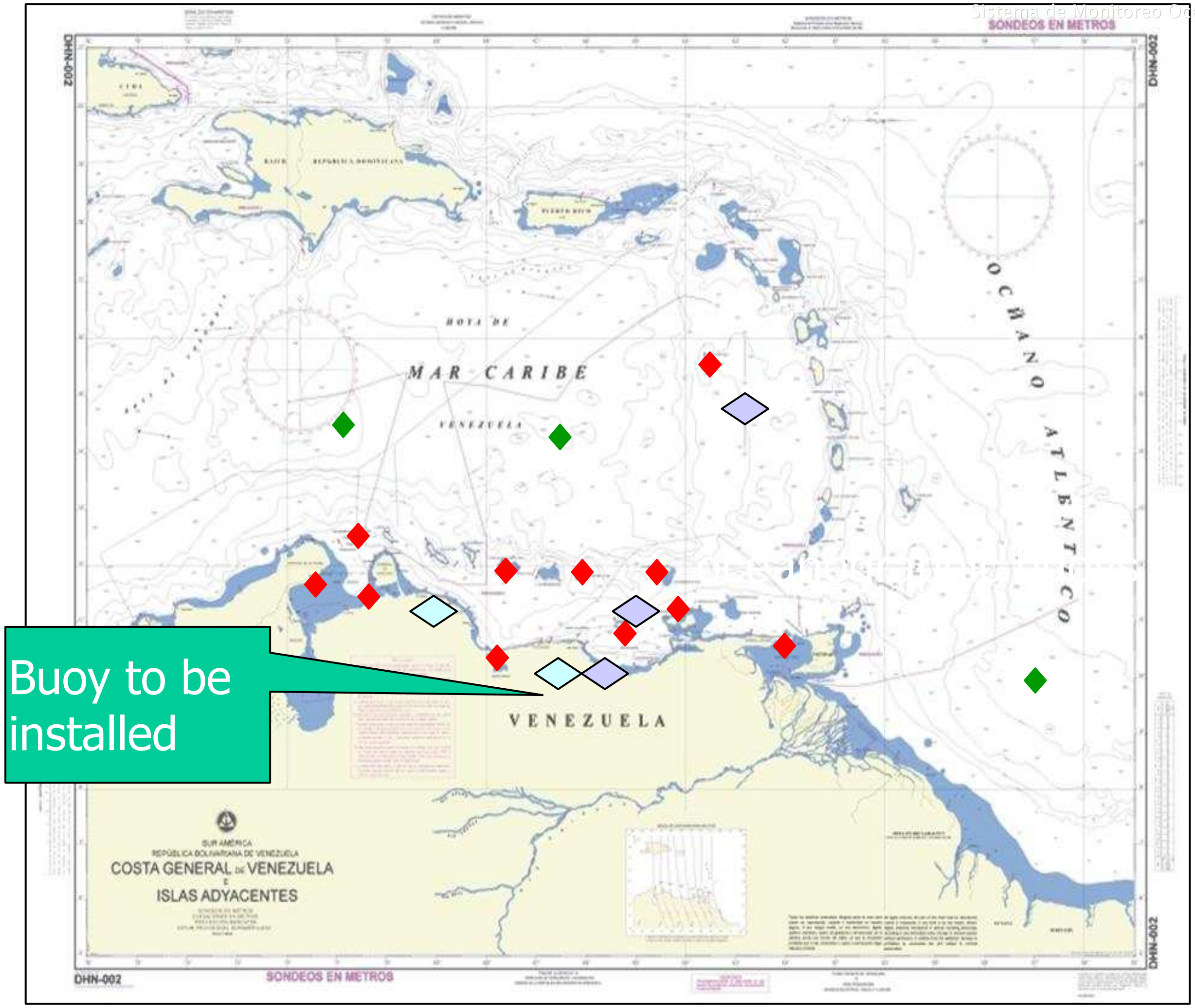
El sismo se localiza a: 14. Km al suroeste de Los Teques (AZIMUTH: 200. GRADOS)
24. Km al noroeste de Cúa (AZIMUTH: 289. GRADOS)

(HLV): Hora Local de Venezuela
(UTC): Tiempo Universal Coordinado
(grados N): Grados Norte
(grados W): Grados Oeste

www.funvisis.gob.ve
0800 - TEMBLOR

Venezuela AHORA ES DE TODOS

Oceanographic Monitoring System



Oceanographic buoys from coastal monitoring systms of Navy and Environmental Ministery, application in offshore Gas projects

Hidrometeorological stations: Aves La Orchila and Mamo

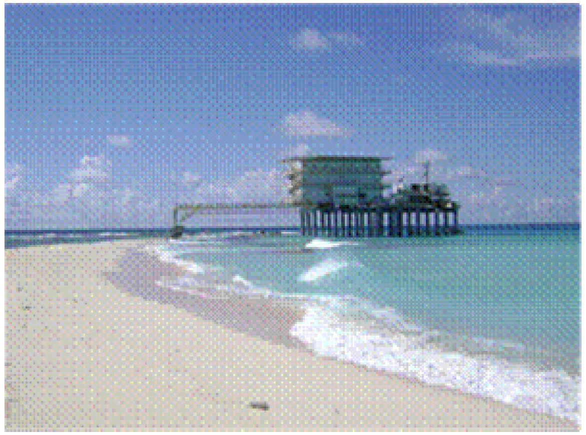
INAMEH

Installation of 13 pressure sensors foreseen within Tsunami hazard warning system

Existing installations

ISLA DE AVES

PUERTO DE LA GUAIRA






AULA SÍSMICA – training of multipliers and comunities

Concerns and goals for the future

2011 - Upgrade the national seismological network:
back-up system with a second new receiver antenna for the whole network
15 new sites for the BB network
replacement of existing 5 BB sensors with new sensors
15 portable seismic stations
80 new accelerographic stations
10 GPS stations.

Strengthening of efforts directed towards the standardization of network parameters via affiliation to FDSN and IRIS; adjustment of existing stations

In a first step, it is foreseen to exchange data from stations SANV, PCRV, LUEV

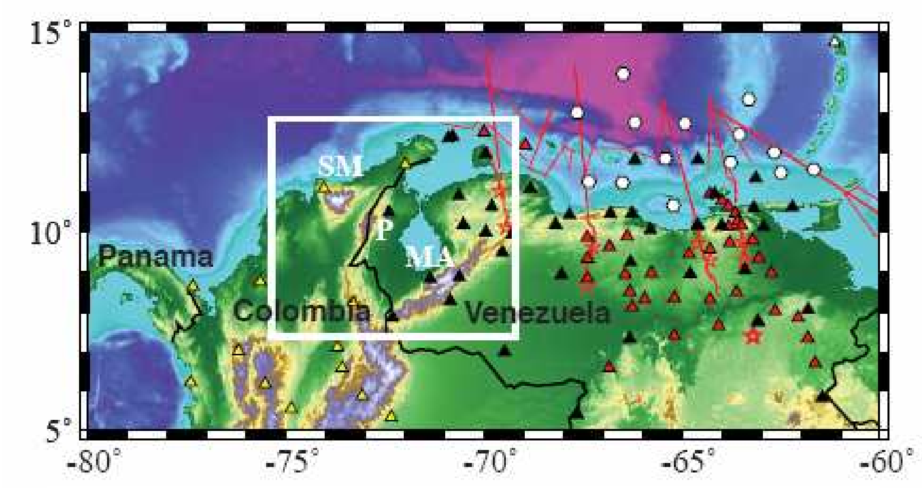
Joint regional seismological studies on the Caribbean plate integrating data and research efforts

Projects:
MAPS (Rice University, FUNVISIS, INGEOMINAS) and
VANDALS (FUNVISIS, UCV, ULA)

Training of seismologists: Geophysics at UCV and USB, Physics at ULA, UDO, UCV; no specific graduate study program

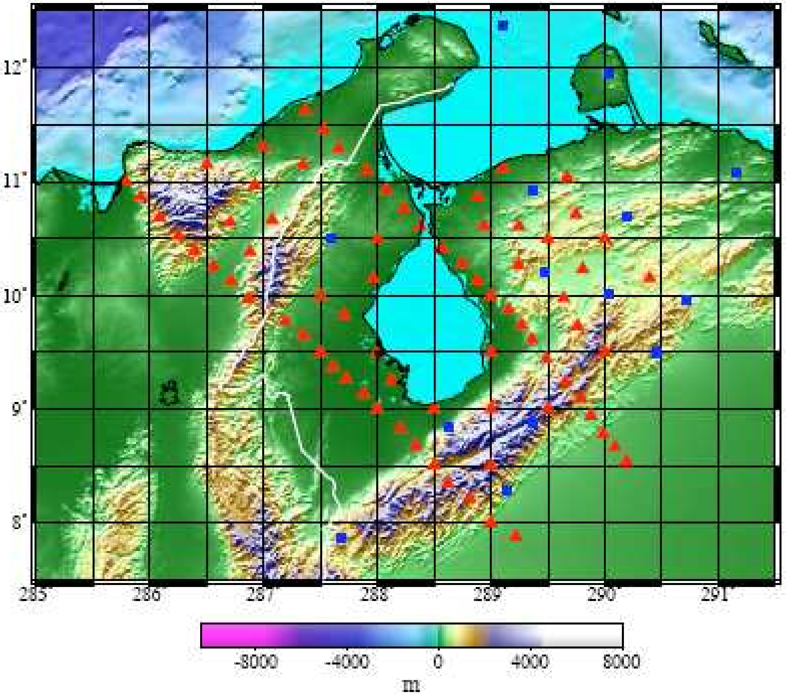
Seismological research: temporary networks

MAPS (Rice University, FUNVISIS, INGEOMINAS)



BOLIVAR (2003 – 2005) network in eastern Venezuela

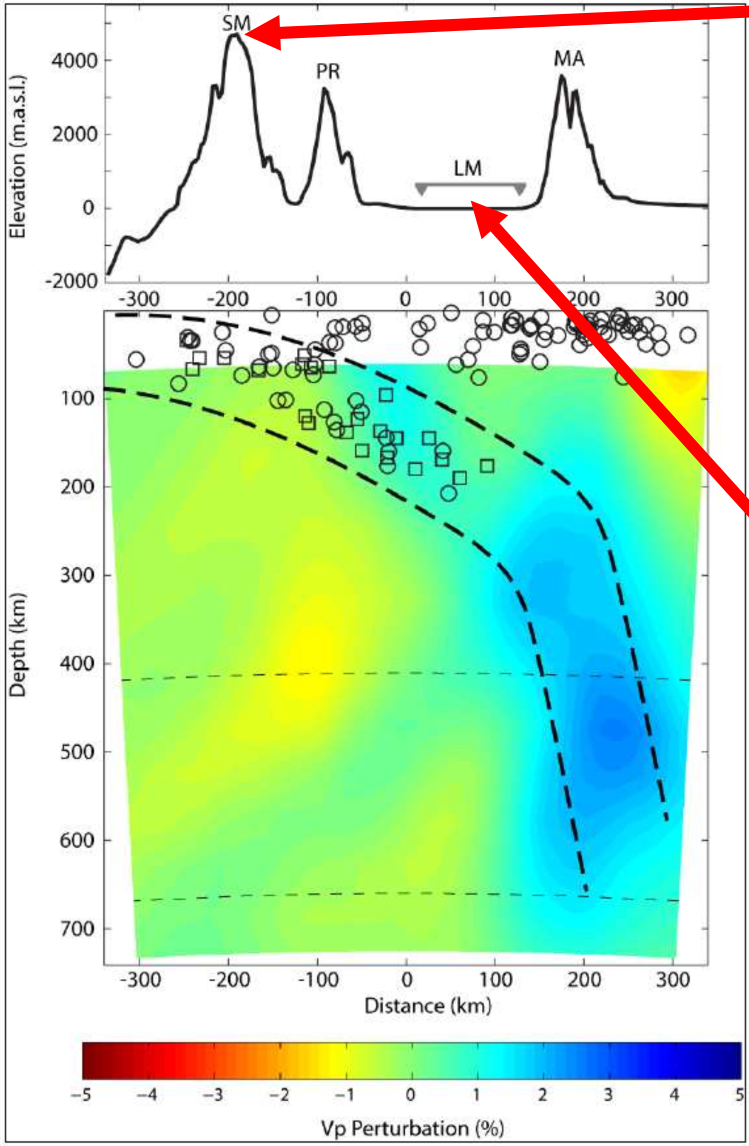
MAPS (2010-2012) - proposal
Merida Andes Preija Santa Marta Seismological Network



MAPS (2010-2012)
75 BB stations covering Caribbean – South America plate interaction

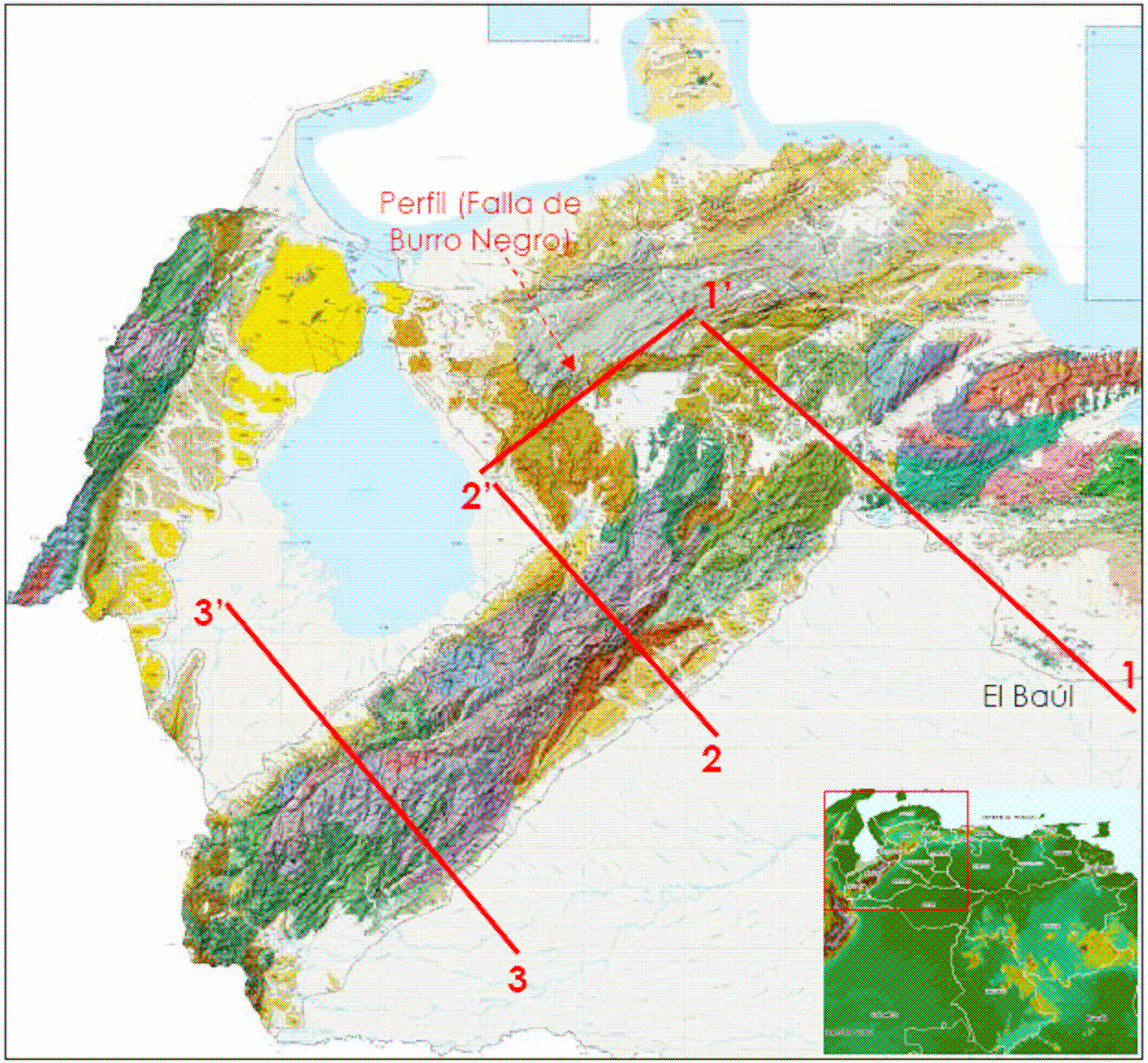
MAPS network area

Bezada et al., 2010



Seismological research: geophysical studies

VANDALS (FUNVISIS, UCV, ULA)



Venezuelan **A**ndes **D**ynamic **a**nd **L**ithosphere **S**tudies (2010 – 2012)

Active seismic studies crossing Merida Andes

Gravity and magnetics, flexural modeling

Permanent deformations (paleoseismology, fission track, cinematics, etc.)

Petrology

Priorities for regional collaboration

Data exchange via Earthworm; experience in station evaluation and standardization of observatory practice is highly appreciated

Joint regional seismological studies on the Caribbean plate integrating data and research efforts, for example:
Common tomografic model for the Caribbean
Modeling of tsunami potential

Joint development of seismic hazard models (seismicity, active faults, seismogenic models) (GEM)

Revision of seismological catalogue

Standardization of building codes / incorporation of local studies (Seismic microzoning), closer interaction with structural engineers

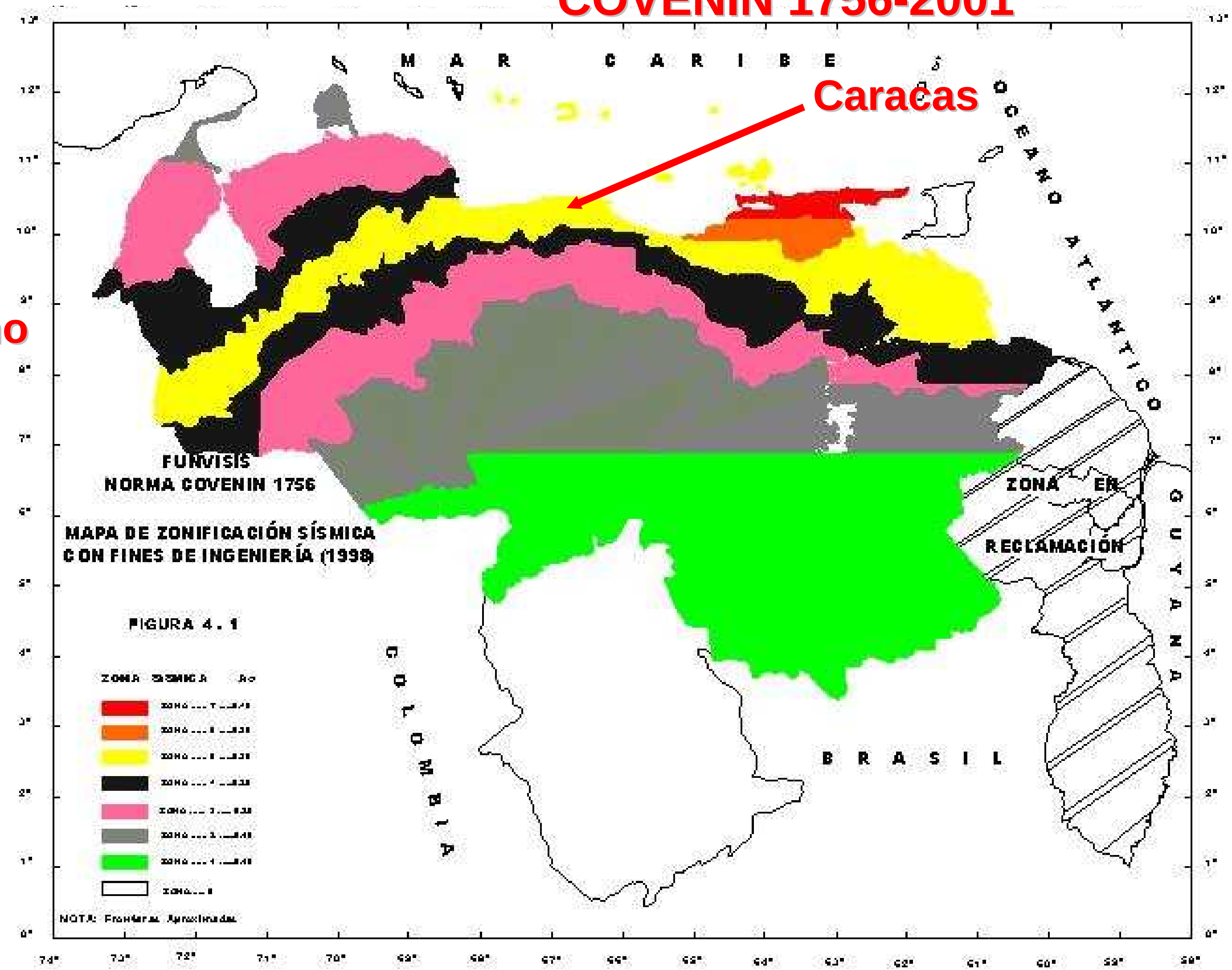
New concepts and research regarding strong motion network (building instrumentation, experimental transfer functions, etc.)

Mitigation of seismic risk through educational efforts (public in general, schools) and retrofitting of existing buildings

Use of seismlogical data in Venezuela: Building code COVENIN 1756-2001

Seismic Hazard Map

(no volcano Hazard)



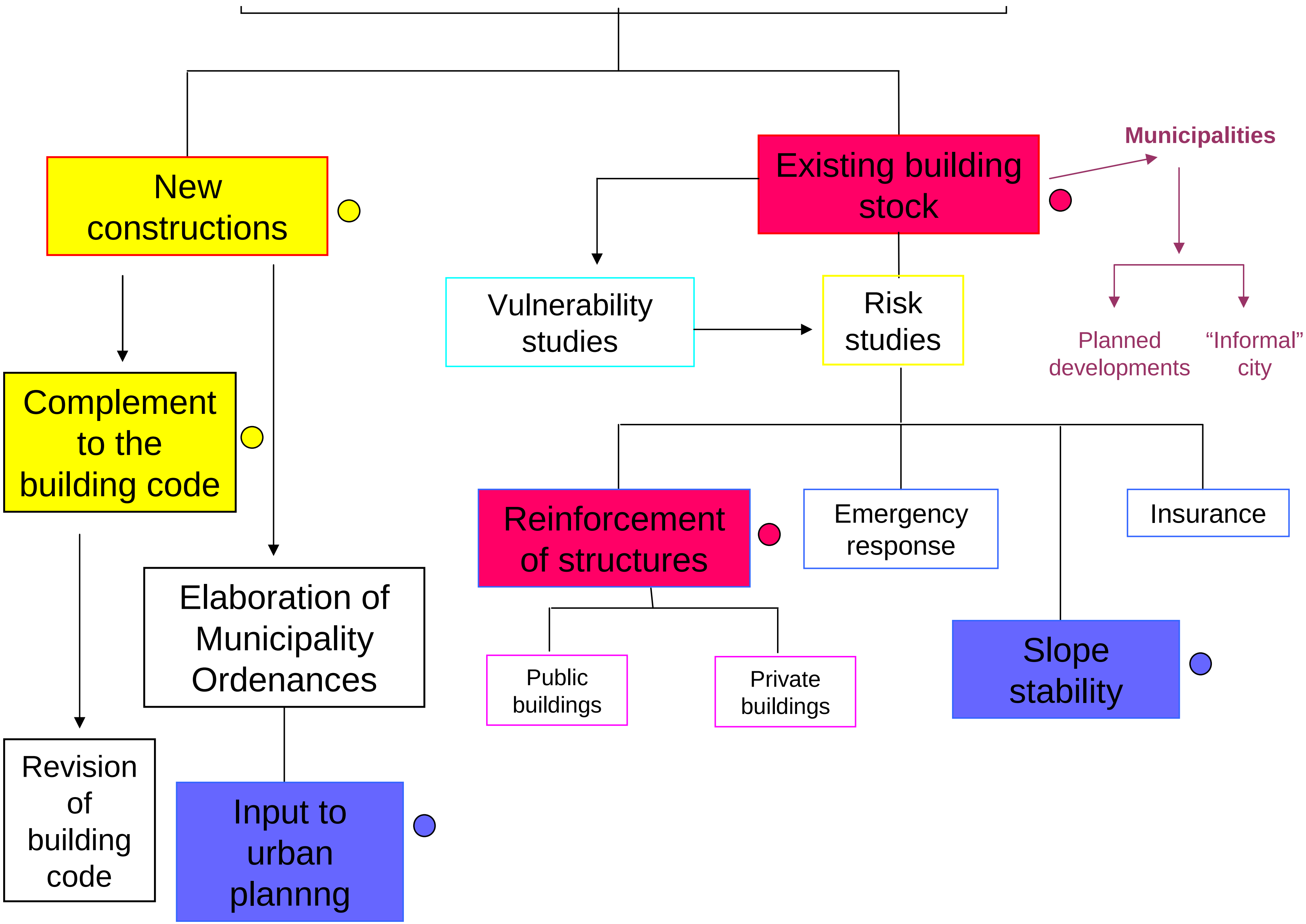
- Caracas: zone of high seismic hazard (0.3 PGA at rock surface)
- Design spectra vary only due to soil clasification for the upper 50 m
- No consideration of basin effects determined after the 1967 earthquake

Seismic microzoning, recent situation: Caracas

3.5 Million inhabitants mainly distributed in high rise buildings in the valley, and informal buildings on deeply weathered steep slope areas

Strong increase in population, high demand of housing area

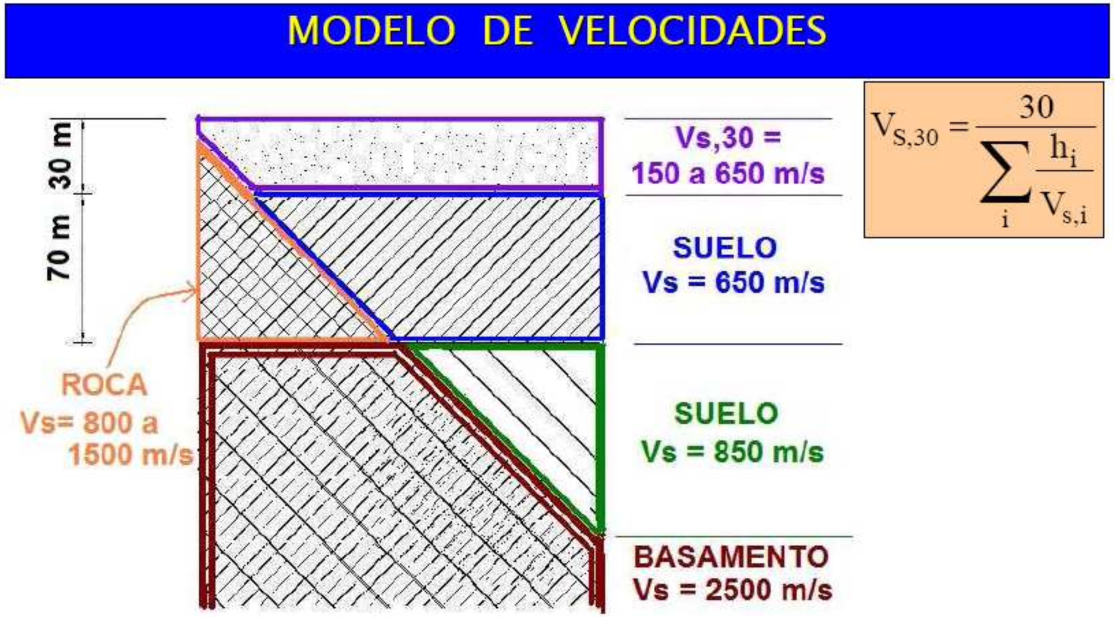
Use of Seismic Microzoning Information



Development of design spectra in microzones

Parametric evaluation of response spectra for groups of profiles using SHAKE
4 classes of sedimentary depth
3 classes of soil quality (Vs30)

H, depósito (m)	$V_{S,30}$ (m/s)		
	≤ 185	185 a 325	> 325
< 60	GP-01	GP-02	GP-03
60 a 120	GP-04	GP-05	GP-06
120 a 220	GP-07	GP-08	GP-09
> 220	GP-10	GP-11	GP-12



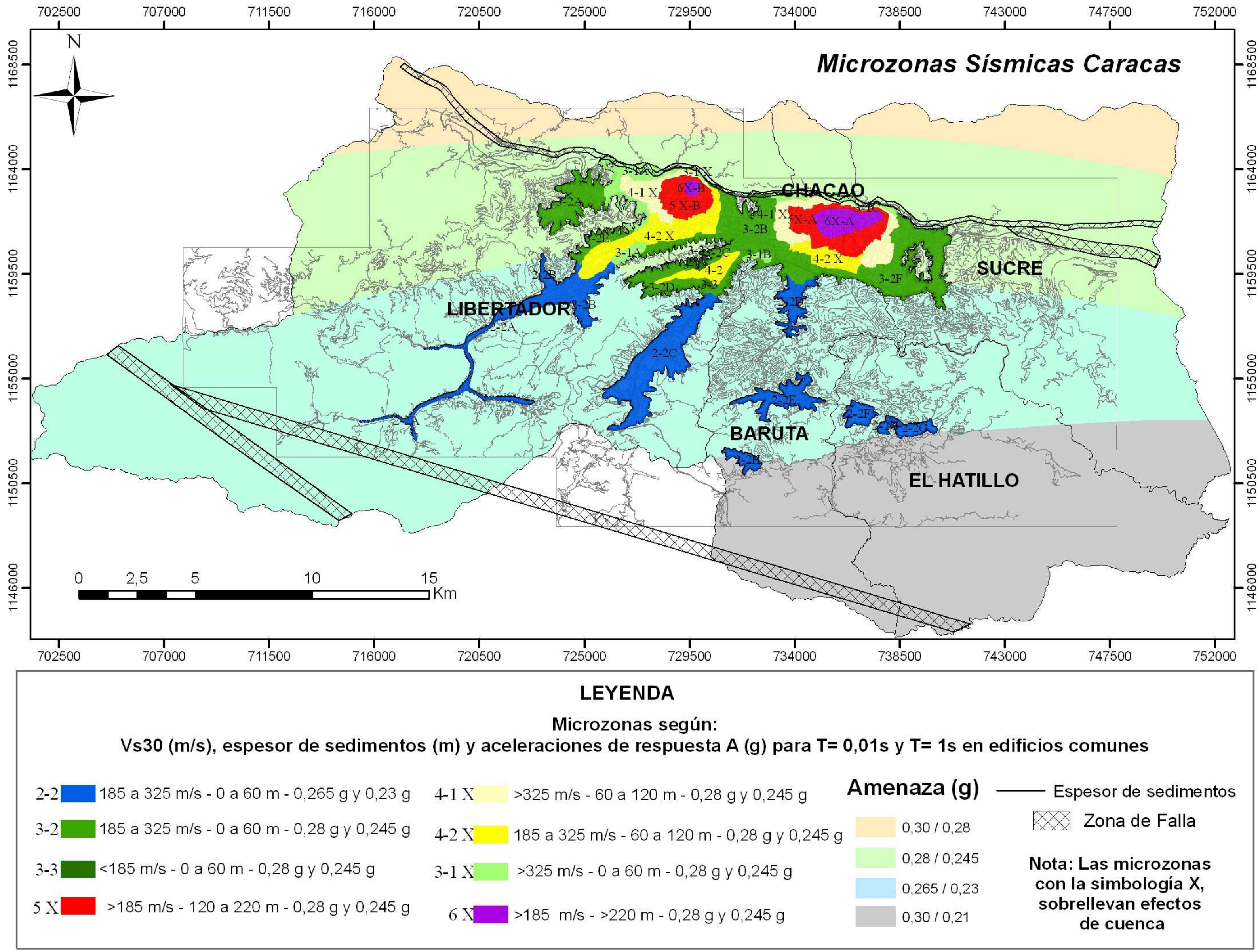
$$V_{S,30} = \frac{30}{\sum_i \frac{h_i}{V_{s,i}}}$$

Clasification of geotechnical profile based on seismic information (variation for Vs30 and sedimentary depth)

Calibration of response spectra with geotechnical data from 4 deep drillholes

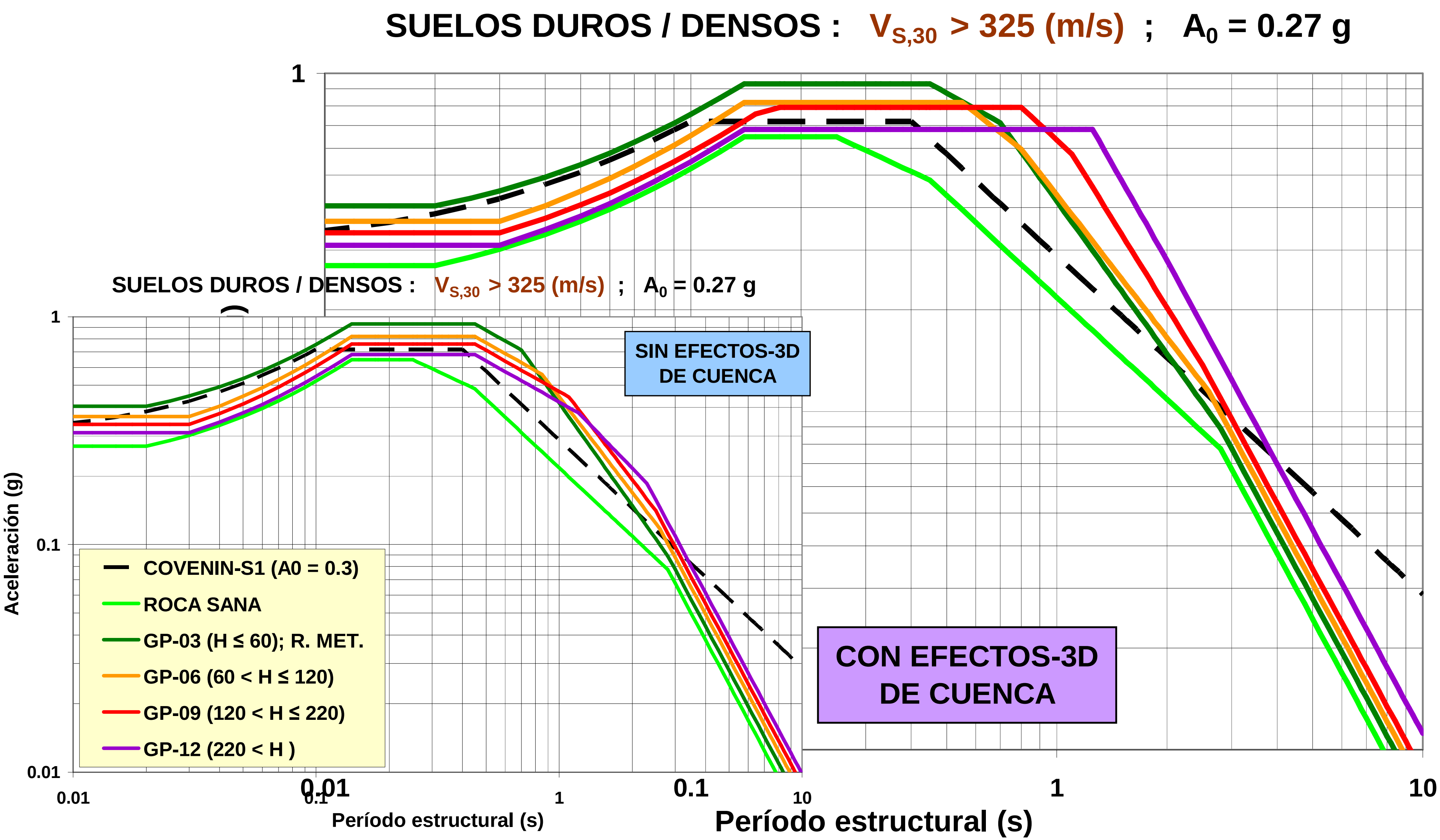
Smooting of response spectra in order to define adjusted basic building code spectra

Zones of similar seismic response



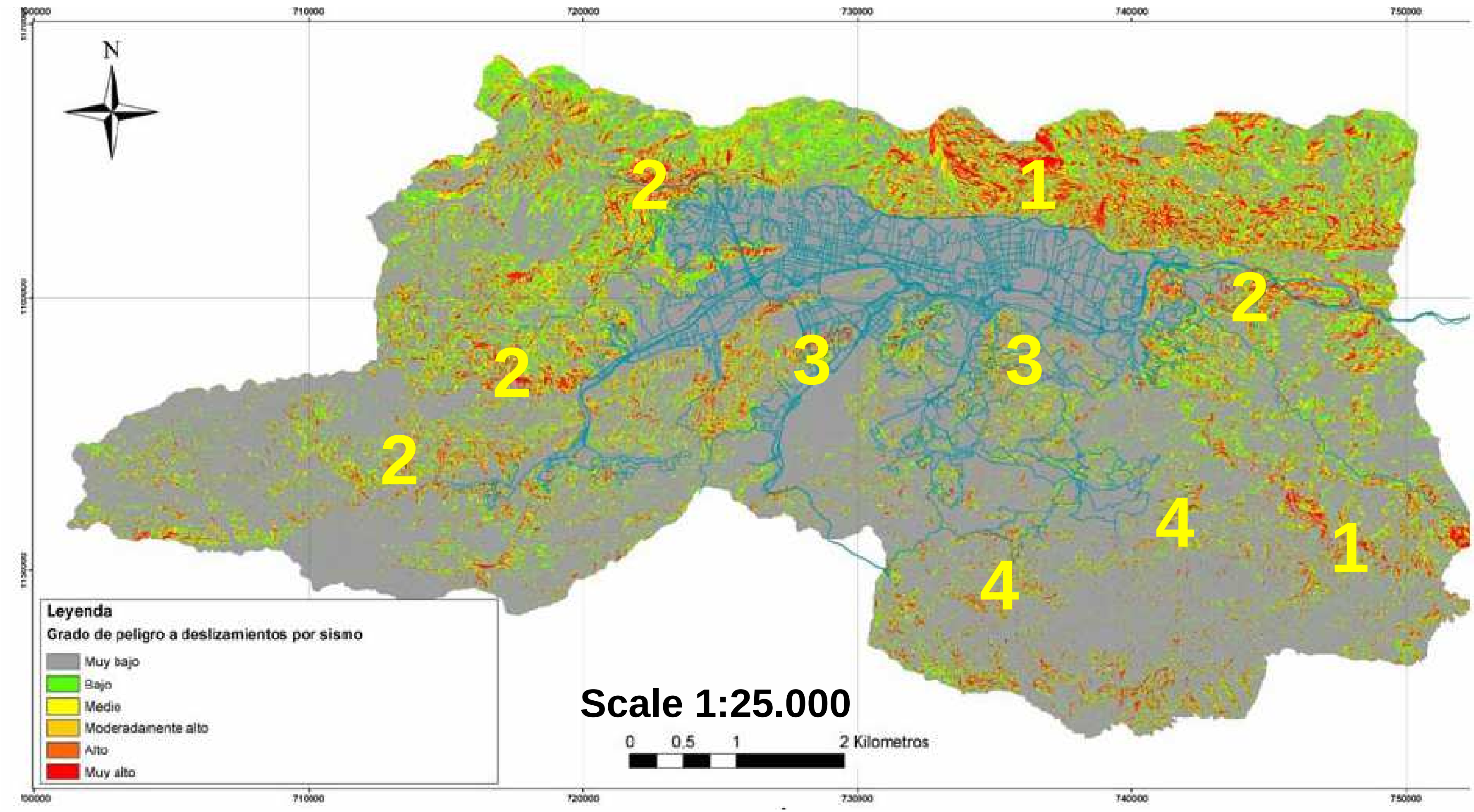
Macrozones: seismic hazard at bedrock, 0.21g, 0.24 g, 0.27 g and 0.3 g; Avila fault zone
Microzones limited by sediment thickness, Vs30, geomorphic units and damage distribution

Incorporation of 3D basin effects, adjusted basic spectra



Adjusted basic building code spectra for groups of profiles, stiff soils and for rock, without 3D basin effects (left), and with 3D basin effects (right); spectra for stiff soils from the seismic building code (dashed line) for reference

Landslide hazard, triggered by earthquakes



High hazard areas:

1) Avila mountains in the north (National park area) and Guaire river canyon in the SE

2) Informal housing areas in the west and the east

3) Housing developments south of the valley

4) Future extension zones to the south

Parametric study of building behaviour

Shallow deposits: Less than 120 m — **Deep deposits:** More than 120 m

NORMA DISEÑO C/A	NORMA SÍSMICA		DEPÓSITOS SOMEROS Edif. BAJOS	DEPÓSITOS SOMEROS Edif. MEDIANOS	DEPÓSITOS SOMEROS Edif. ALTOS	DEPÓSITOS PROFUNDOS Edif. BAJOS	DEPÓSITOS PROFUNDOS Edif. MEDIANOS	DEPÓSITOS PROFUNDOS Edif. ALTOS
MOP-39	MOP-39		29%	28%	20%	28%	43%	38%
MOP-47	MOP-47	Rs > 2	46%	67%	70%	45%	76%	83%
MOP-47	MOP-47	Rs ≤ 2	34%	37%	31%	32%	52%	51%
MOP-55	MOP-55	No ofic.	37%	72%	91%	37%	80%	95%
MOP-55	MOP-55	Ofic.	33%	54%	68%	32%	67%	82%
MOP-55	MOP-67		19%	12%	6.3%	17%	24%	17%
MOP-CA-TC-67	MOP-67		13%	5.3%	2.1%	11%	13%	7.5%
ACI 318-71 = COVENIN 1753-81	MOP-67		8.1%	1.9%	0.56%	7.3%	6.0%	2.7%
ACI 318-71 = COVENIN 1753-81	COVENIN 1756-82		5.3%	2.1%	3.0%	4.9%	7.1%	6.2%
ACI 318-80 = ATC 3-06	COVENIN 1756-82		3.1%	0.81%	1.1%	2.8%	3.5%	2.7%
COVENIN 1753-85	COVENIN 1756-82		1.8%	0.34%	0.47%	1.6%	1.7%	1.3%
COVENIN 1753-85	COVENIN 1756-98		0.45%	0.050%	0.085%	0.27%	0.11%	0.043%
COVENIN 1753-85	COVENIN 1756:2001		0.98%	0.80%	0.76%	0.87%	3.5%	2.0%
COVENIN 1753-85	PMZS-CCS		0.43%	0.80%	1.1%	0.43%	0.80%	1.1%

*Violeta: elevada; Rojo: grande; Naranja: alarmante; Verde: tolerable; Azul: poco importante.

Exceedence probability of severe damage for a sesmic scenario with "A0 ~ 0.28 g" #

Reinforcement priorities:

Buildings constructed previous o 1967

Medium to high rise buildings located on deep deposits

Importance of structural irregularities

Low risebuildings: up to 5 stories
Medium height buildings: 6 to 14 stories
High rise buildings: more than 15 y stories

Hernández, 2009

Application of the results of the seismic microzoning project

Existing buildings:

Parametric evaluation of vulnerability of buildings considering age and number of stories (application of building codes from 1955 / 1967 / 1982 / 2001)

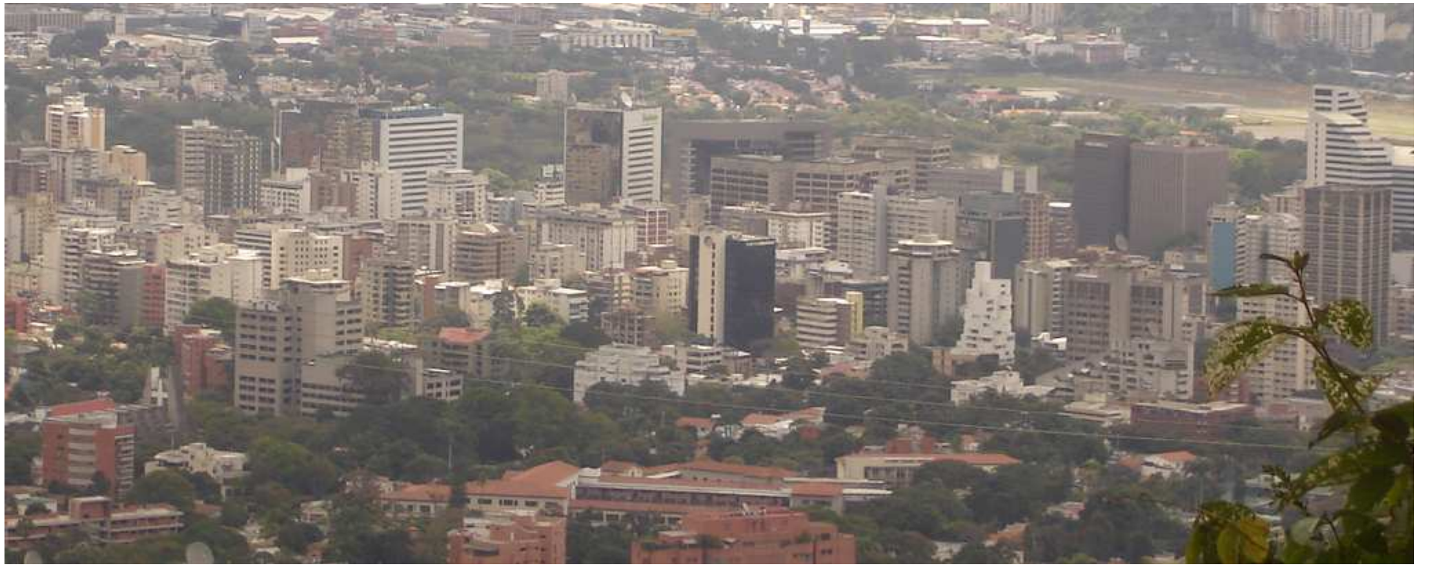
Need for study the distribution of buildings regarding to the respective microzones

Definition of priorities for reinforcement studies and political guidelines for their implementation

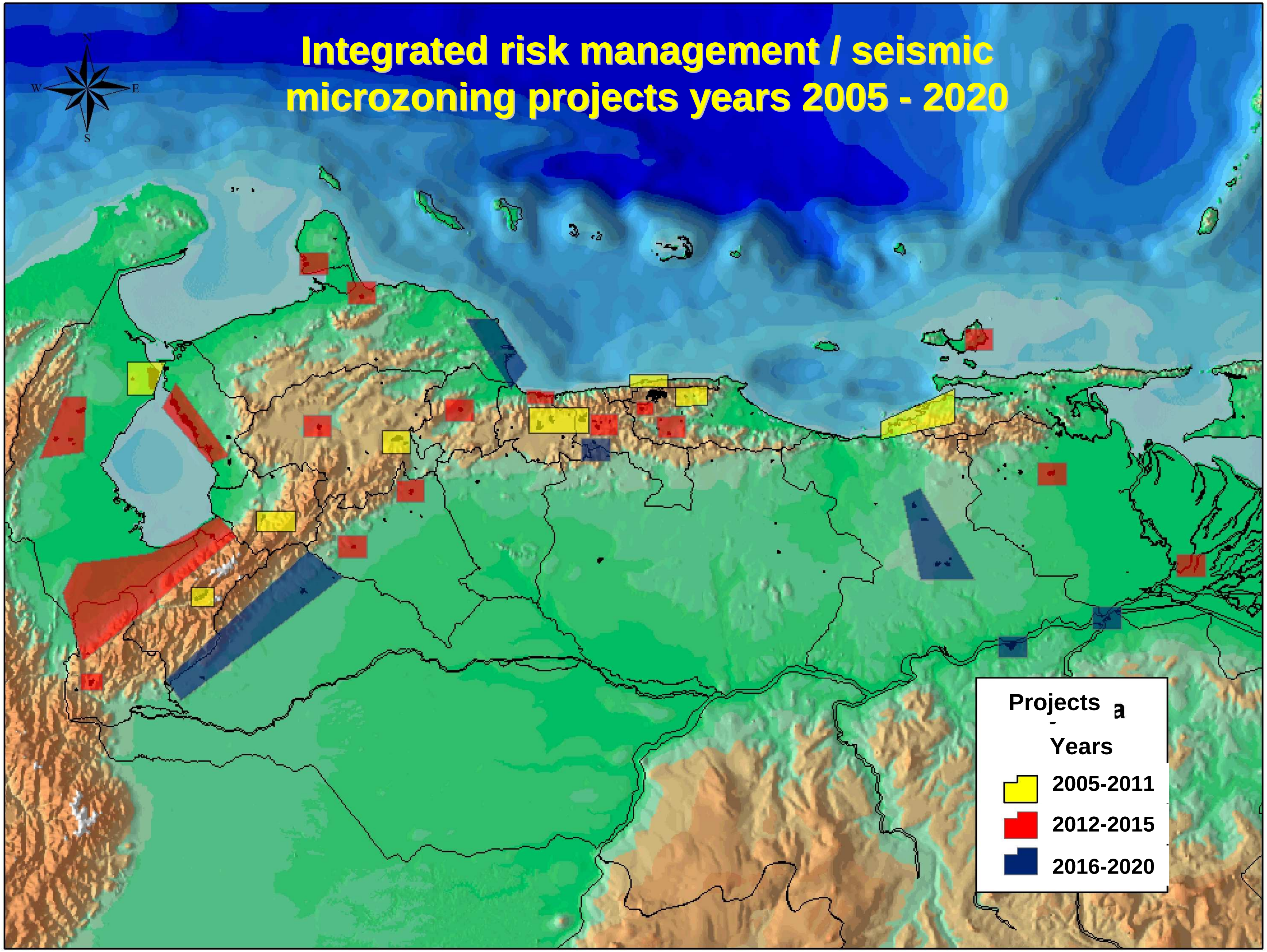
New buildings:

Application of response spectra for each microzone – incorporate results of seismic microzoning in new version of seismic building code (2009/2010)

Training of engineers; supervision mechanisms; definition of methdological standards for other cities



Risk management / seismic microzoning projects

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Thanks for your attention