The Regional Cost of a Natural Disaster

A tsunami generated by the Palos Verdes Submarine Landslide offshore of Los Angeles, California

Jose Borrero
Research Assistant Professor
Department of Civil and Environmental Engineering

Sungbin Cho,
Research Associate
School of Policy, Planning, and Development

James E. Moore II,
Professor
Departments of Industrial and Systems Engineering and Civil and Environmental Engineering, and the School of Policy, Planning, and Development

Costas Synolakis,
Professor
Department of Civil and Environmental Engineering

Abstract

Recent developments in modeling of tsunami waves and economic impact analysis are combined with data from recent offshore mapping to model the mechanism and economic impact of a tsunamigenic undersea landslide in the vicinity of Los Angeles.

Modeling Tools

Tsunami
MOST

Method **O**f **S**plitting
Tsunami

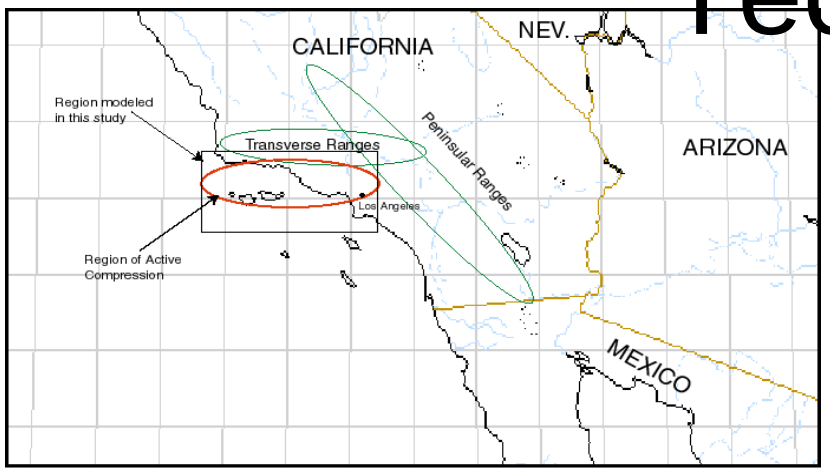
- Includes wave generation, propagation and runup
- Validated in numerous cases at both laboratory and field scales

Economic
SCPM I & II

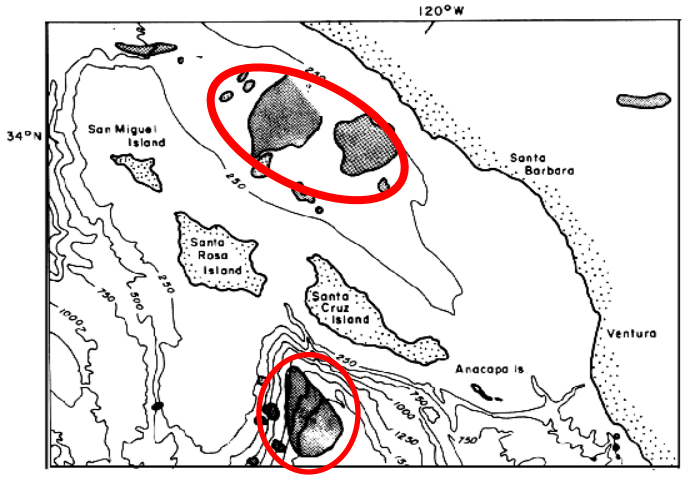
Southern **C**alifornia
Planning **M**odel

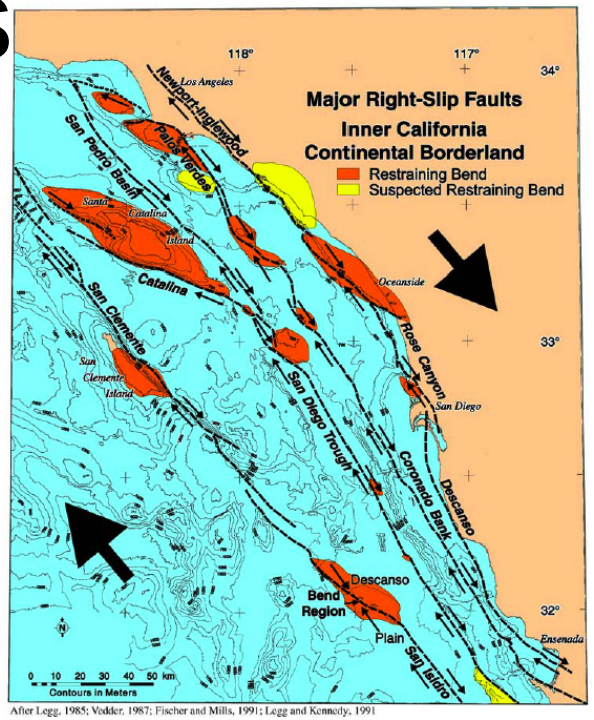
- Regional economic model discretized at the municipal level
- Version II incorporates traffic flows

Southern California Offshore Tectonics



Compressional Tectonics:
Thrust & Reverse Faulting
(vertical tectonic displacements)

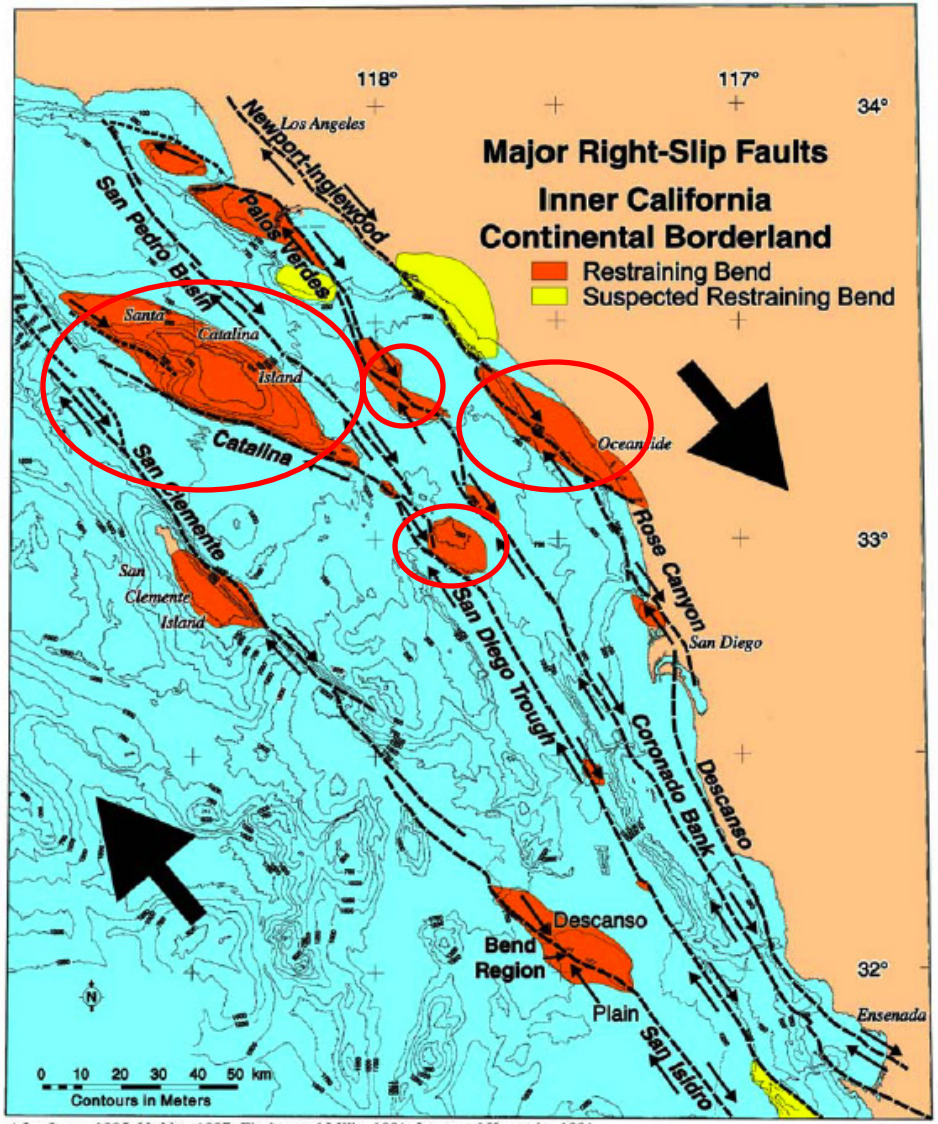




Restraining Bends and Stepovers
(vertical seafloor displacements)

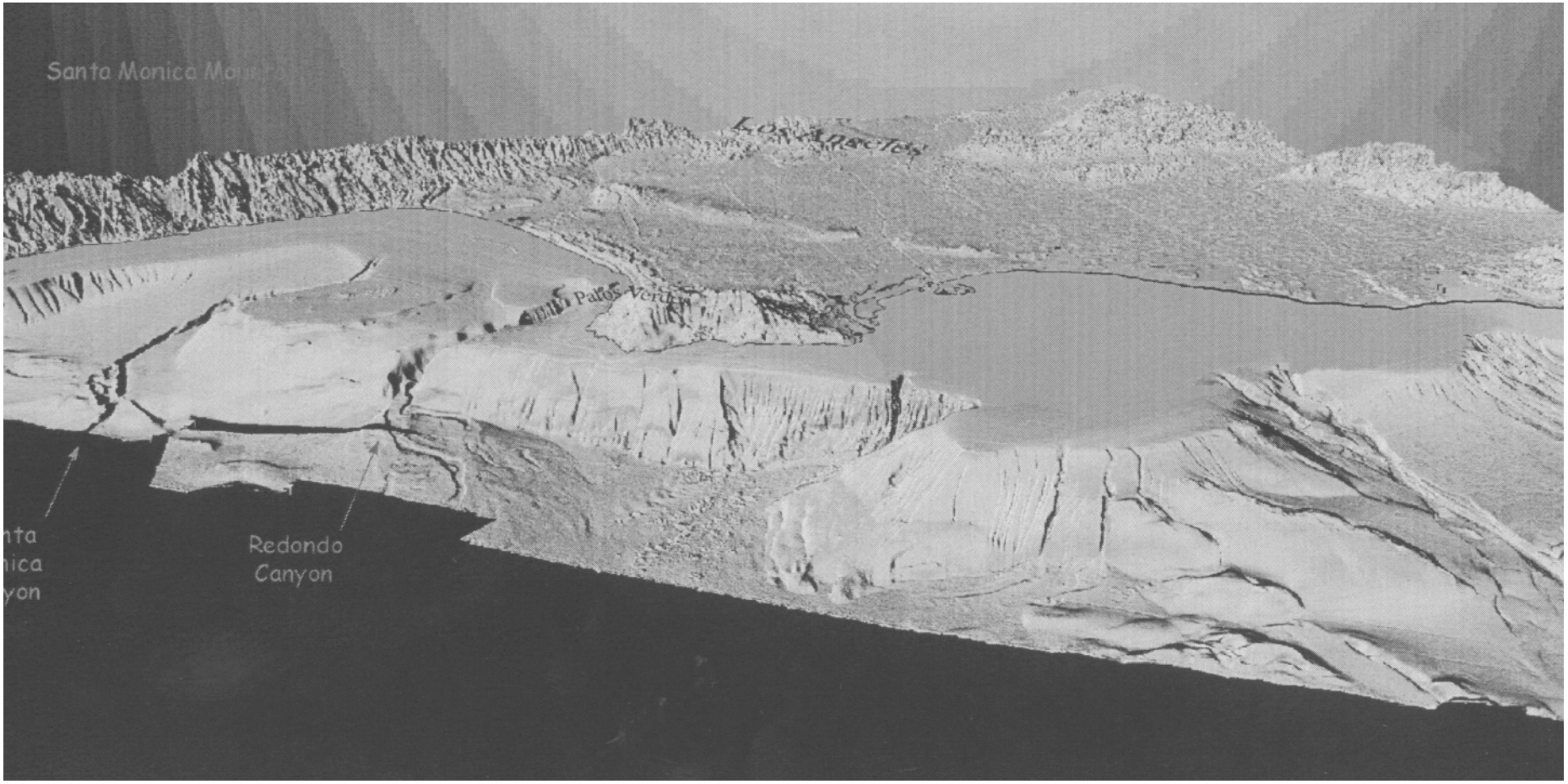
Unstable Offshore Slopes
(with some mapped slides)

Restraining Bends Offshore Southern California



After Legg, 1985; Vedder, 1987; Fischer and Mills, 1991; Legg and Kennedy, 1991

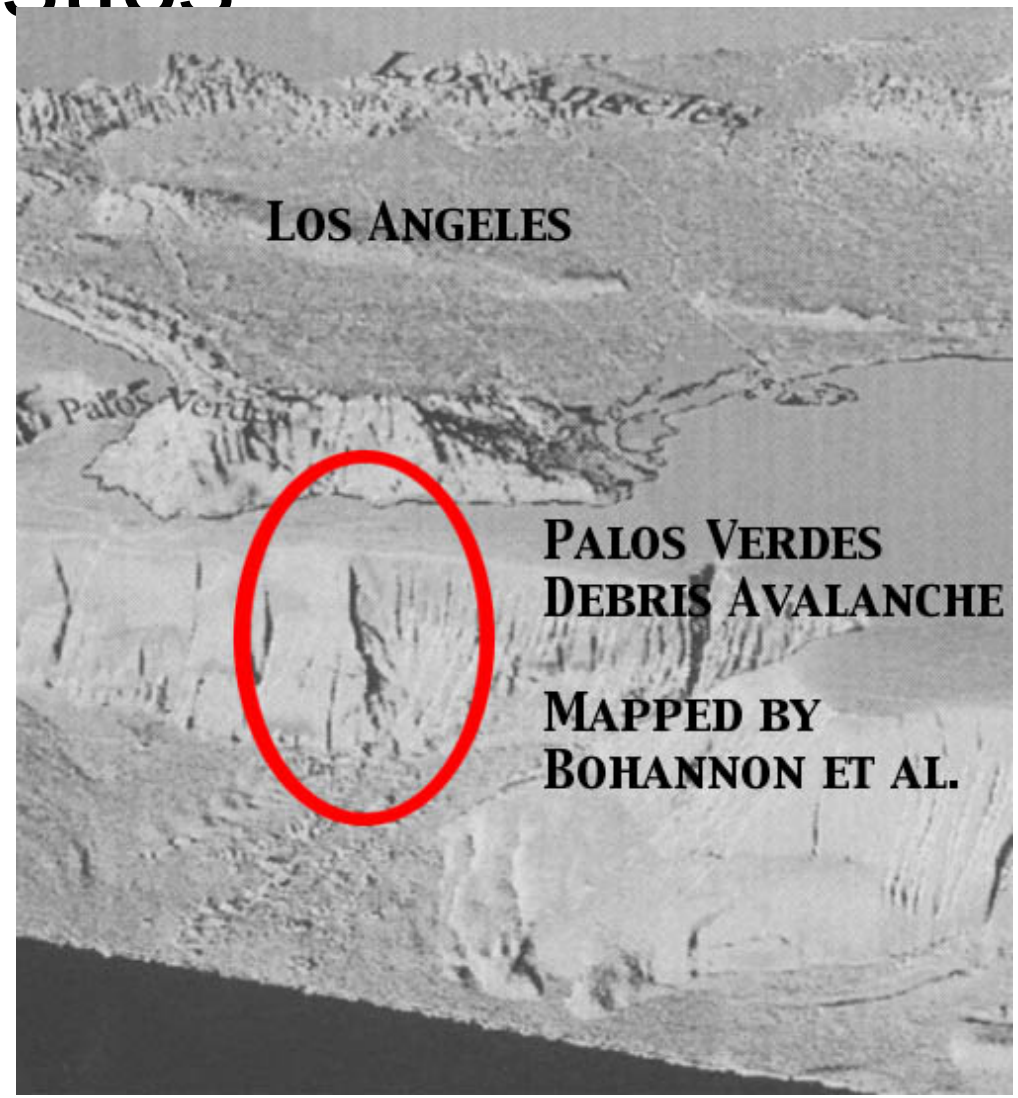
Another potential tsunami source:



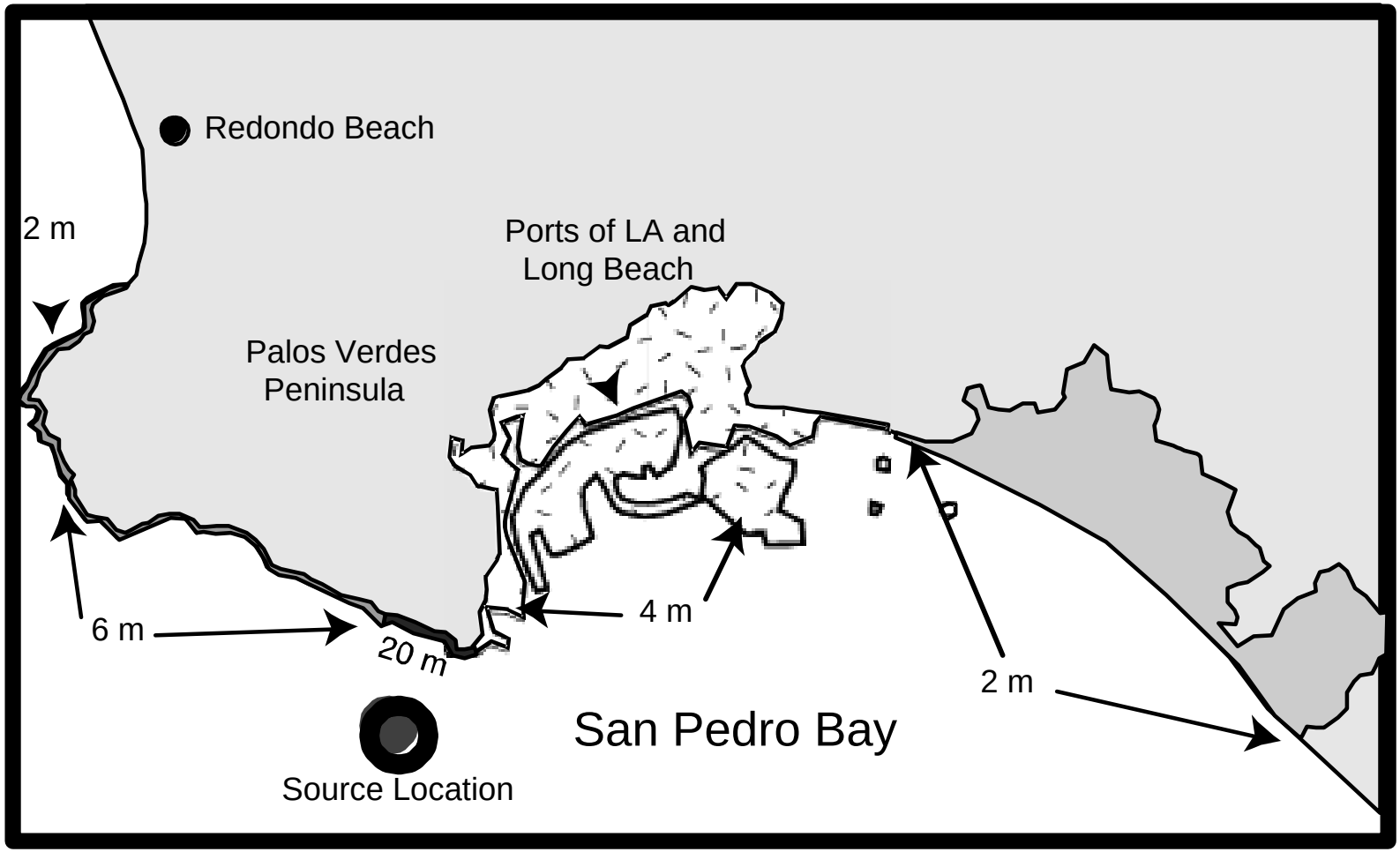
Underwater landslides or slumps

Slide Characteristics

- Debris Avalanche of Bohannon
- 2km wide
- 4.6km long
- 60m deep
- volume .35 to .72 km^3
- depth starts at -100m at top
- -800m at bottom



Inundation Zones



Types of Losses

- Direct
  - Accrued only in inundation zones
- Indirect
  - Accrued throughout the region
- Induced
  - Indirect costs specific to the labor sector

Loss Tables:

City	Baseline ($1000)	Direct Loss ($1000)	Direct Loss as a % of Baseline
Carson	6,591,962	85,736	1.30
Hawaiian Gardens	216,150	323	0.15
Long Beach	22,838,571	3,607,647	15.80
Palos Verdes Estates	416,315	32,338	7.74
Rancho Palos Verdes	510,586	26,903	5.27
Wilmington / San Pedro	5,675,587	314,931	5.55
Unincorporated LA County	17,623,822	2,565	0.01
Garden Grove	4,969,415	190	0.00
Huntington Beach	7,031,246	299,580	4.26
Los Alamitos	1,481,826	12,543	0.85
Rossmoor CDP	120,899	5,761	4.76

	Loss ($1000)	Loss as a % of Total Output[a]
Direct	4,502,257	0.60
Indirect	1,541,117	0.21
Induced	1,325,883	0.18
Total	7,369,257	0.99

Losses Related to Port Activities

Maximum Direct Losses Due to Loss of Port Services.

Industry	Total Exports[a] ($ Millions)	Port Share of exports (%)	Direct Impact ($ Millions)
Mining	158.5	46.90	74.34
Durable	25,172.7	40.61	10,628.73
Non-Durable	37,595.9	23.23	8,732.27
Wholesale	19,394.3	13.05	2,531.60
Sum	82,321.4		21,966.94[b,c]

Direct, Indirect and Induced Losses in port areas

	Economic Impact ($ Millions)	Share of Baseline Total Output (%)
Direct	21,966,941	2.95
Indirect	8,762,751	1.17
Induced	5,451,162	0.73
Total	36,180,854	4.85

4 Scenarios

Scenario 1:

•Direct + indirect + induced business loss in the inundated area.
•**No** freeway links are closed.
•Ports Los Angeles and Long Beach are functional
•No reduction in export capabilities occurs.

Scenario 2:

•Direct + indirect + induced business loss in the inundated area.
•Freeway links are **closed for 1 year**
•Ports Los Angeles and Long Beach are functional
•No reduction in export capabilities occurs.

Scenario 3:

•Direct + indirect + induced business loss in the inundated area.
•Freeway links are closed for 1 year
•Ports Los Angeles and Long Beach are **closed for 1 year**
•No reduction in export capabilities occurs - transferred to other modes of freight.

Scenario 4:

•Direct + indirect + induced business loss in the inundated area.
•Freeway links are closed for 1 year
•Ports Los Angeles and Long Beach are **closed for 1 year**
•**Export flows** that used to be transported through the ports is **now impossible.**

Losses for each Scenario

	Type of Loss			
	Direct Loss (million)	**Indirect Loss (million)**	**Induced Loss (million)**	**Total (million)**
Scenario 1	4,502.257	1,541.117	1,325.883	7,369.257
Scenario 2	4,502.257	1,541.117	1,325.883	7,369.257
Scenario 3	4,502.257	1,541.117	1,325.883	7,369.257
Scenario 4	26,469.198	8,903.868	677.045	43,550.111

Delay Costs and Total Losses

	Driver Delay		Freight Delay		Total Delay	
	PCU Hours	$ Billion	PCU Hours	$ Billion	PCU Hours	$ Billion
Scenario 1	3,806	12.824	-5,198	-31.029	-1,391	-18.206
Scenario 2	31,687	106.751	42,085	251.233	73,772	357.984
Scenario 3	61,445	207.006	89,982	537.158	151,427	744.163
Scenario 4	9,874	33.266	-85,586	-510.917	-75,712	-477.651

	Economic Loss	Network Loss	Total
Scenario 1	7,369.257	-18.206	7,351.051
Scenario 2	7,369.257	357.984	7,727.241
Scenario 3	7,369.257	744.163	8,113.420
Scenario 4	43,550.111	-477.651	43,072.460

Conclusions

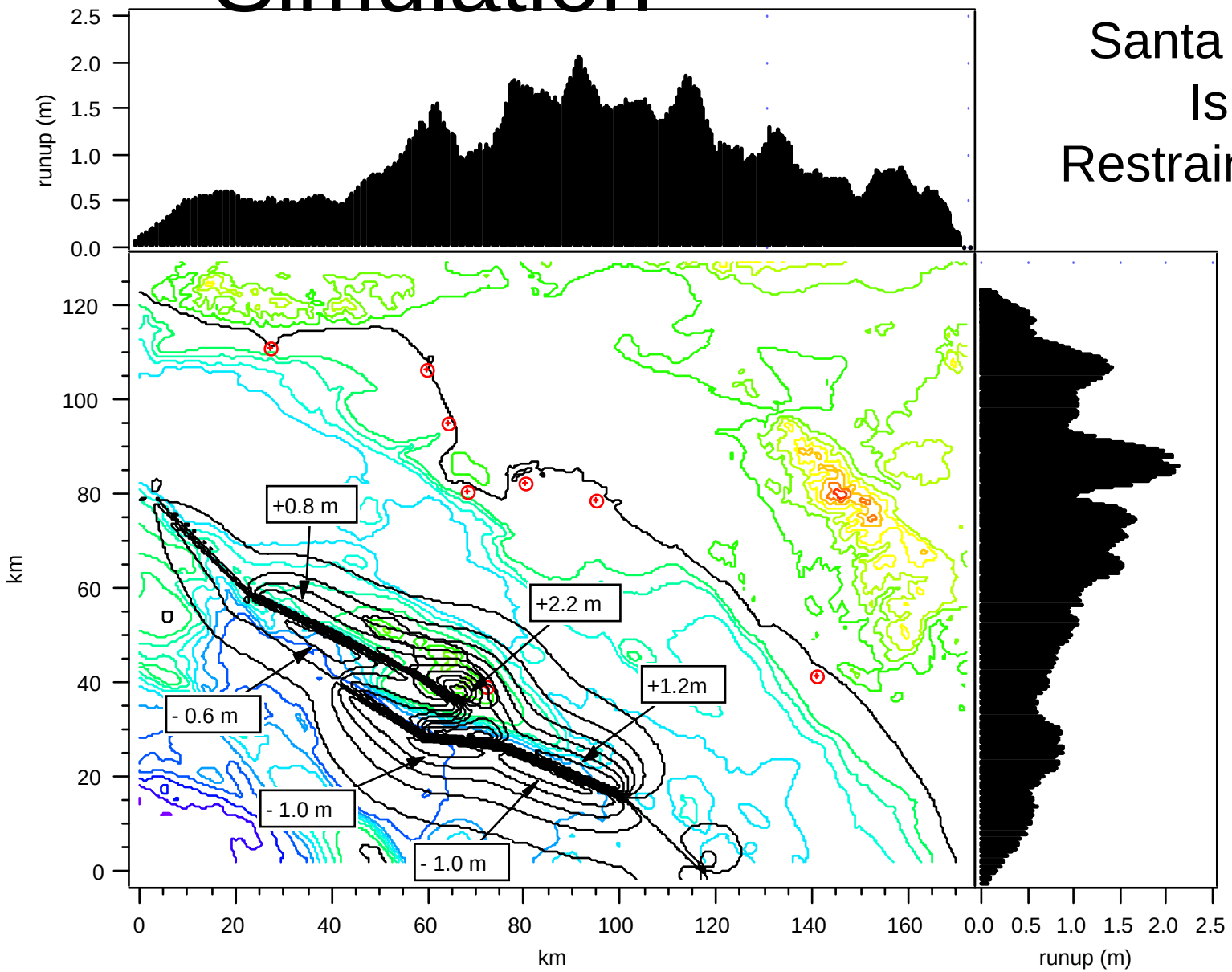
- Costs associated with a local tsunami disaster would include substantial **direct, indirect, and induced costs** associated with lost economic opportunity - these are **not** repair or replacement costs.

- Damage to port facilities could produce much larger losses

- If the loss of port services equates to the loss of export services, then the economic impact of the scenario tsunami is approximately $36 billion in losses.

- The greatest increase in transportation delays occurs in the case where port export flows are forced to switch from the waterways to land based routes, thus creating further congestion and delays on Southern California's transportation network.

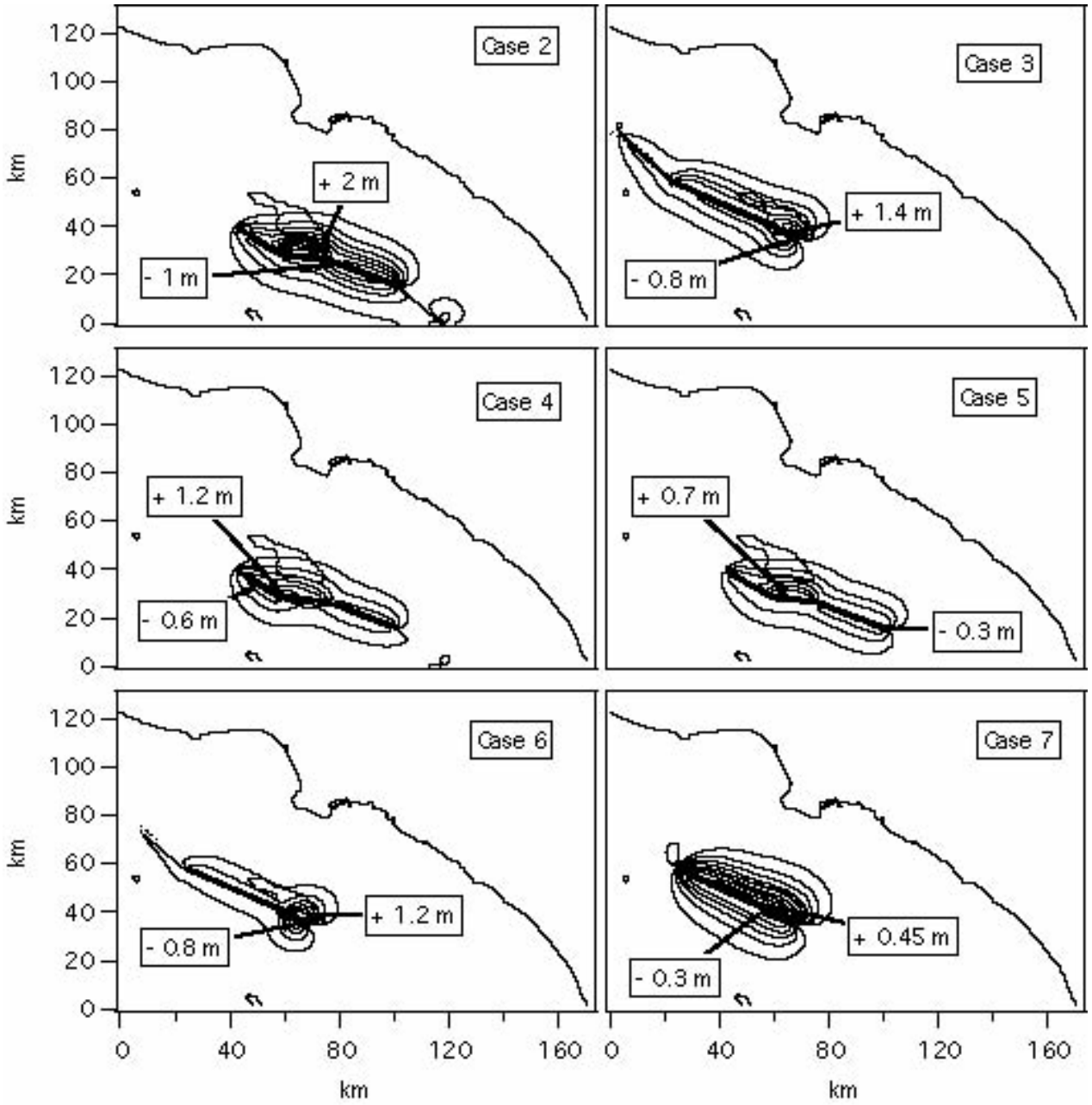
Tsunami Simulation



Santa Catalina Island Restraining Bend

Mw = 7.6

Additional Cases

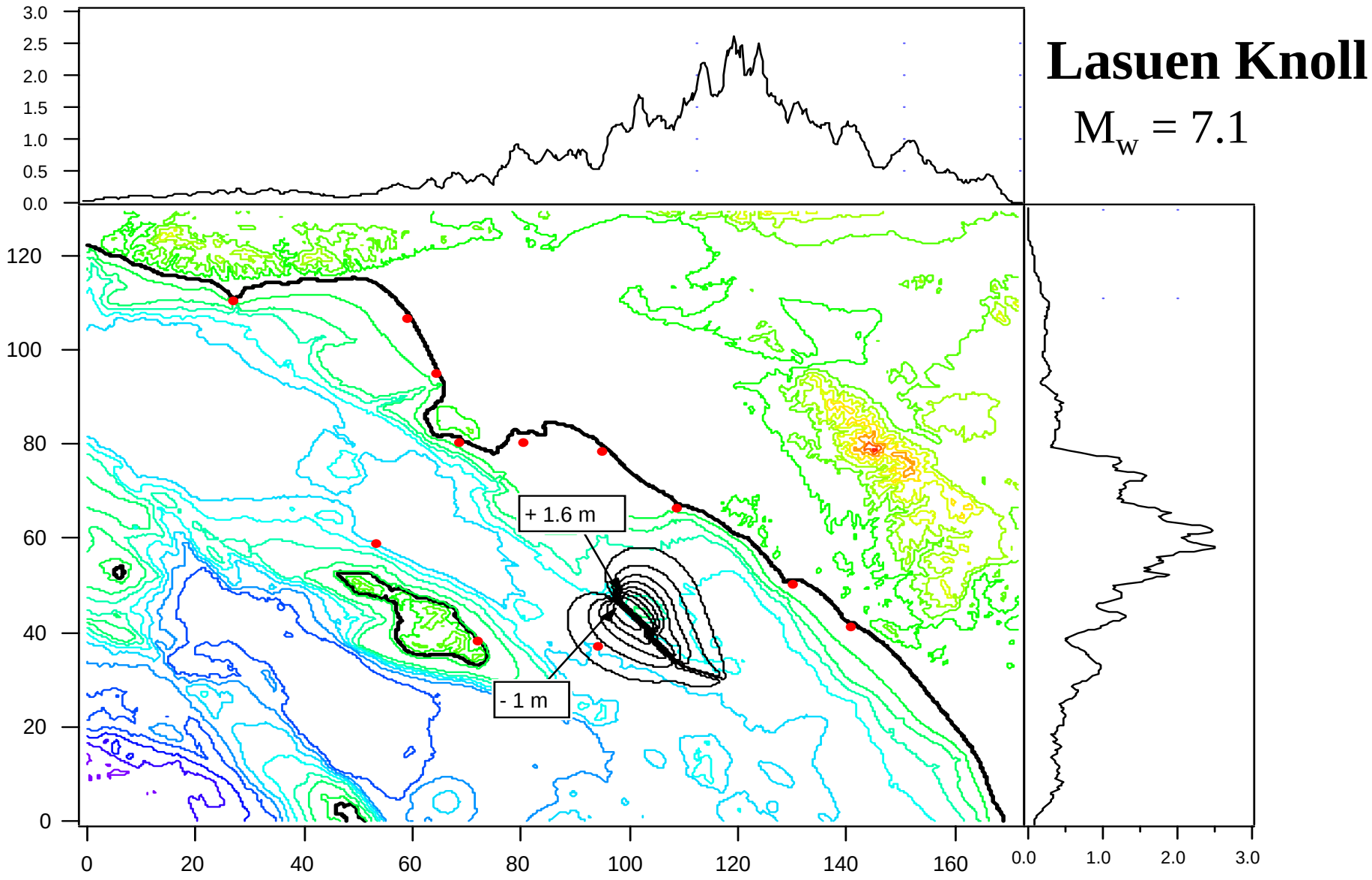


$M_w = 7.0$

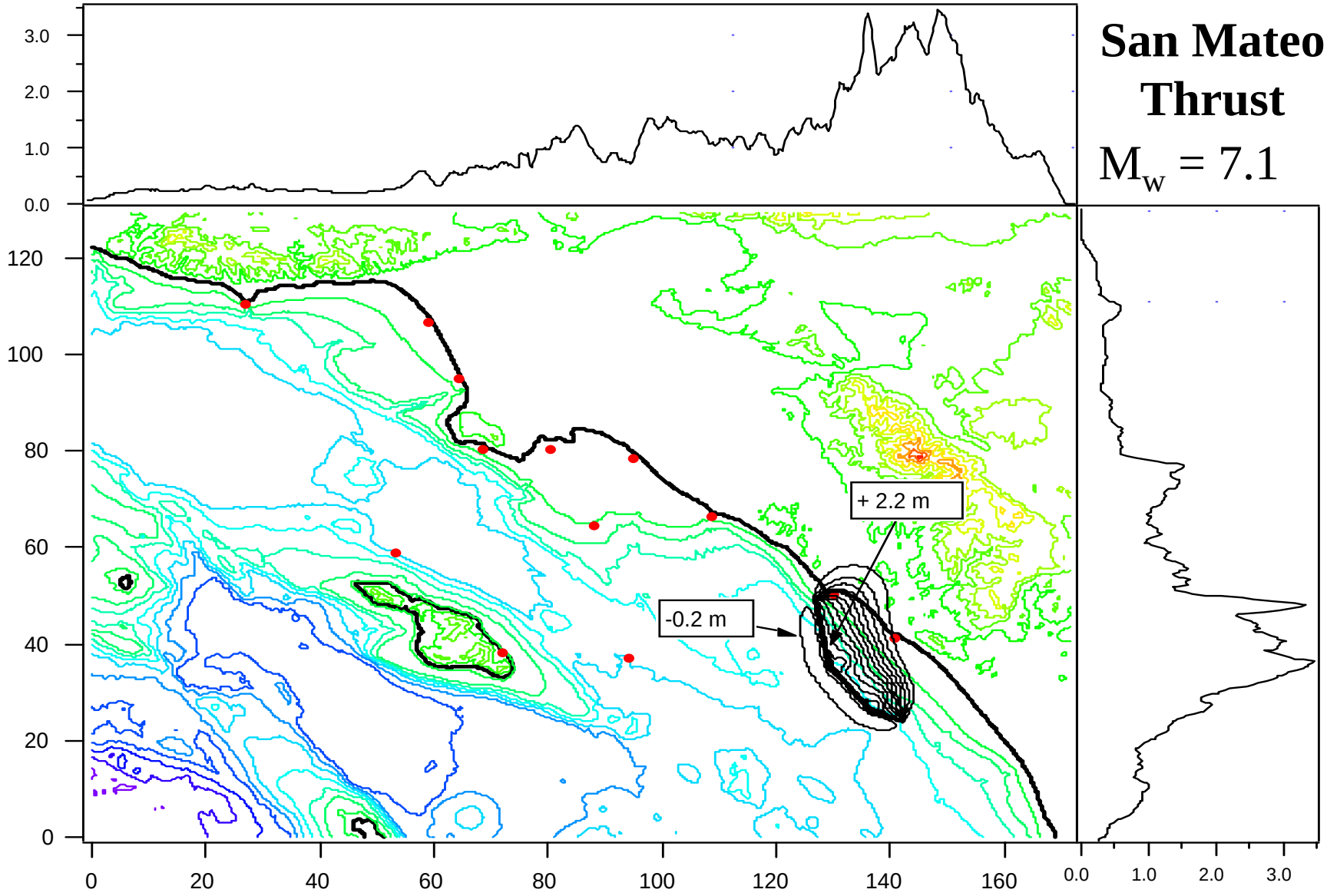
to

$M_w = 7.4$

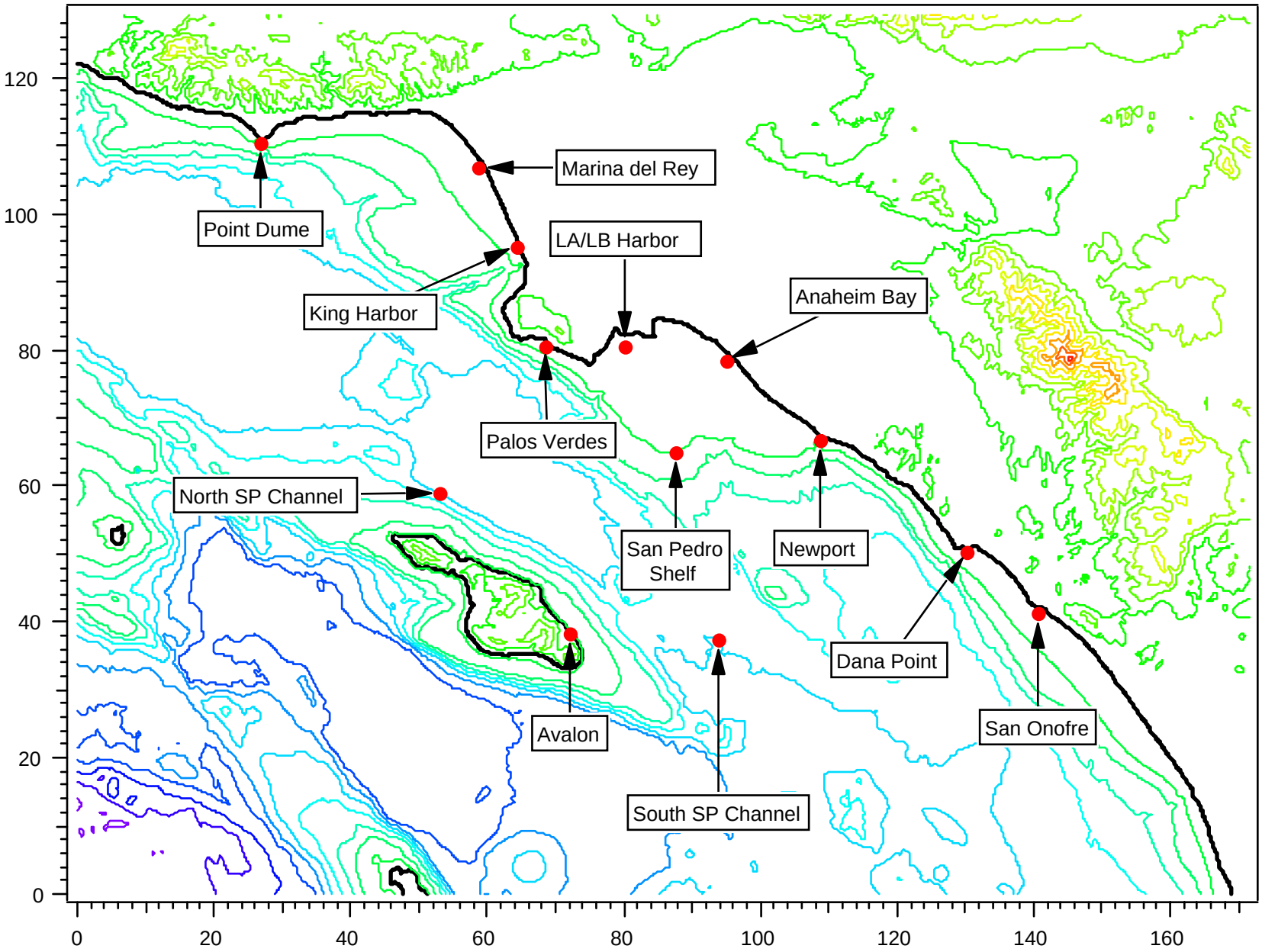
Other Scenarios 1:



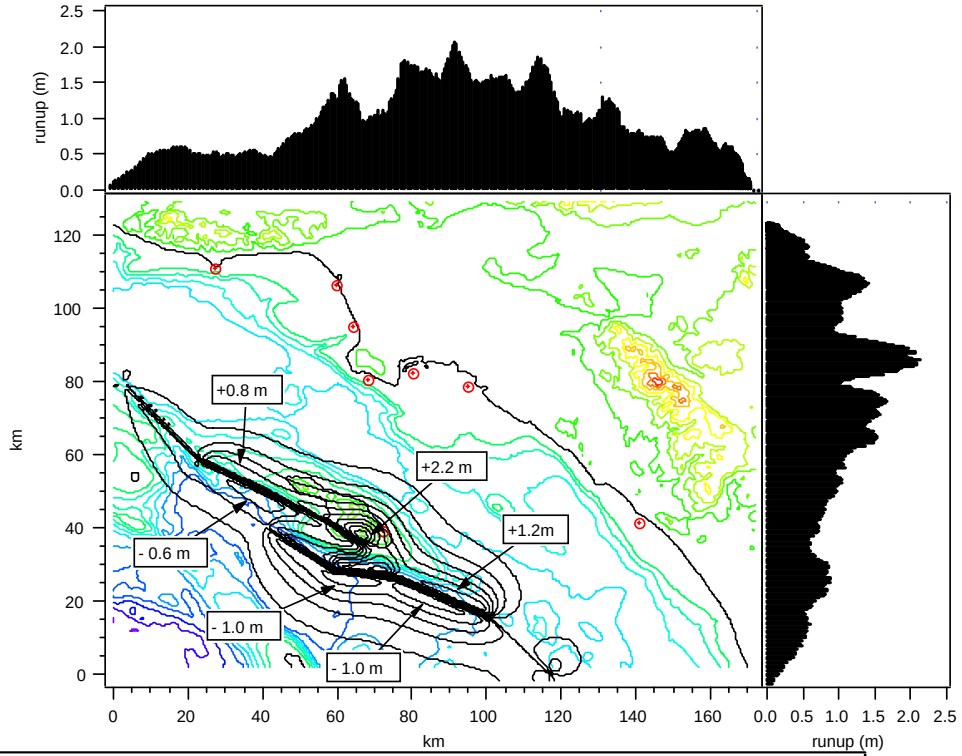
Other Scenarios 2:

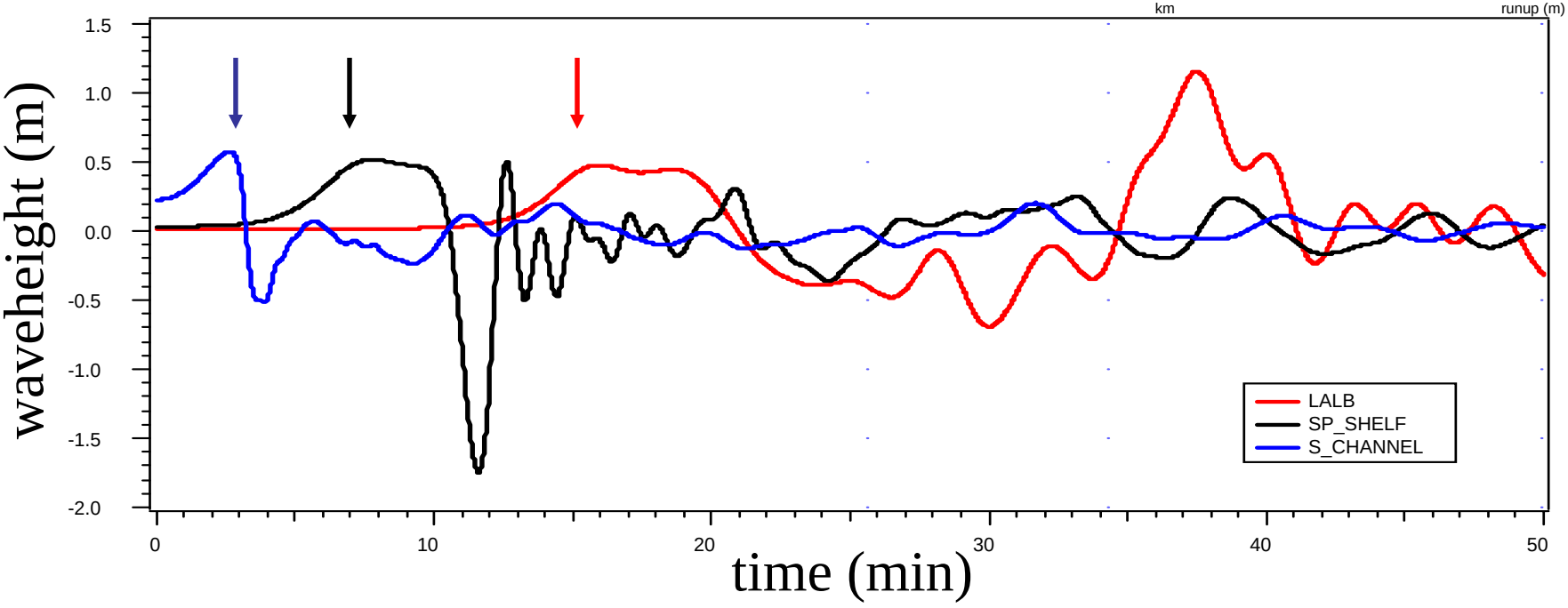


Arrival Times

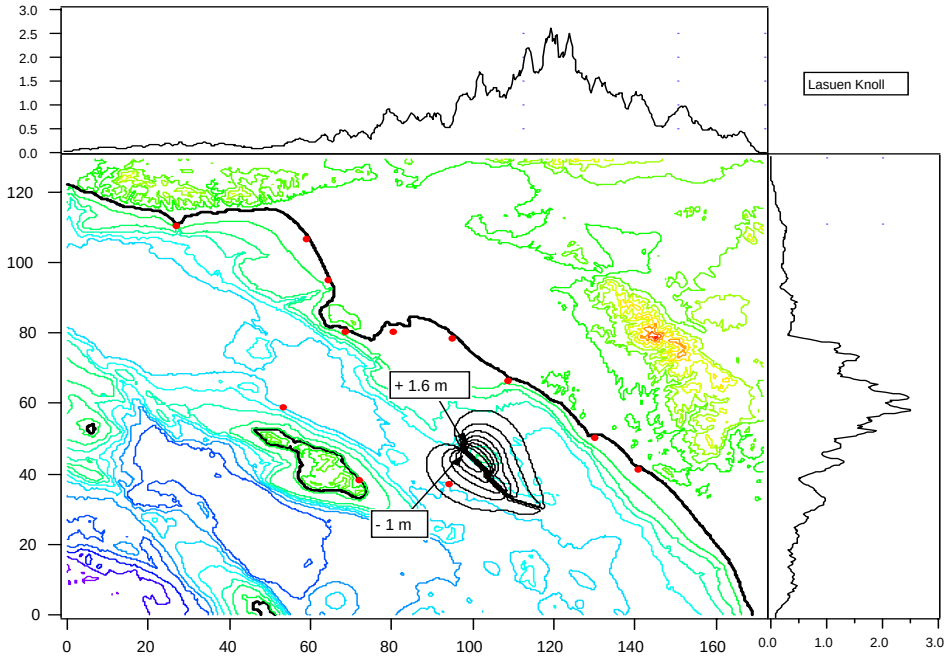


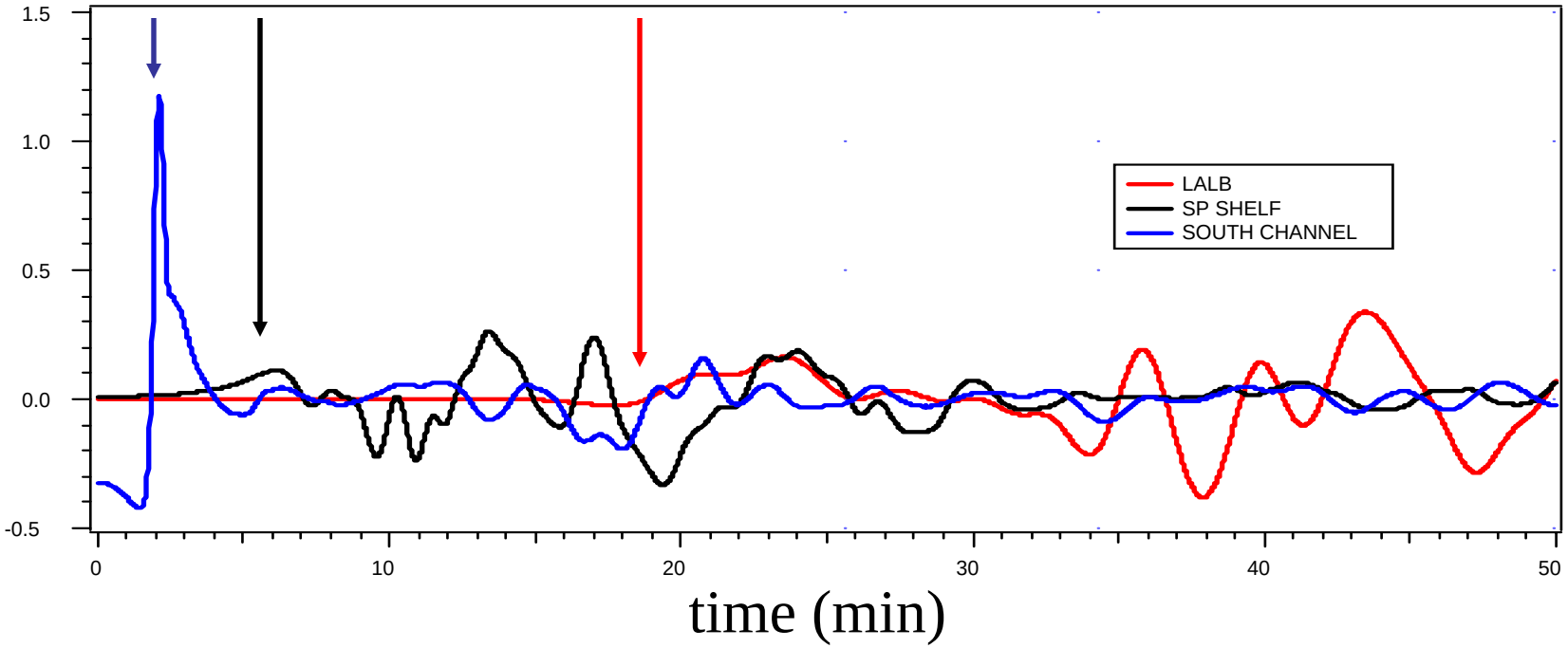
Catalina Fault





Lasuen Knoll





San Mateo Thrust