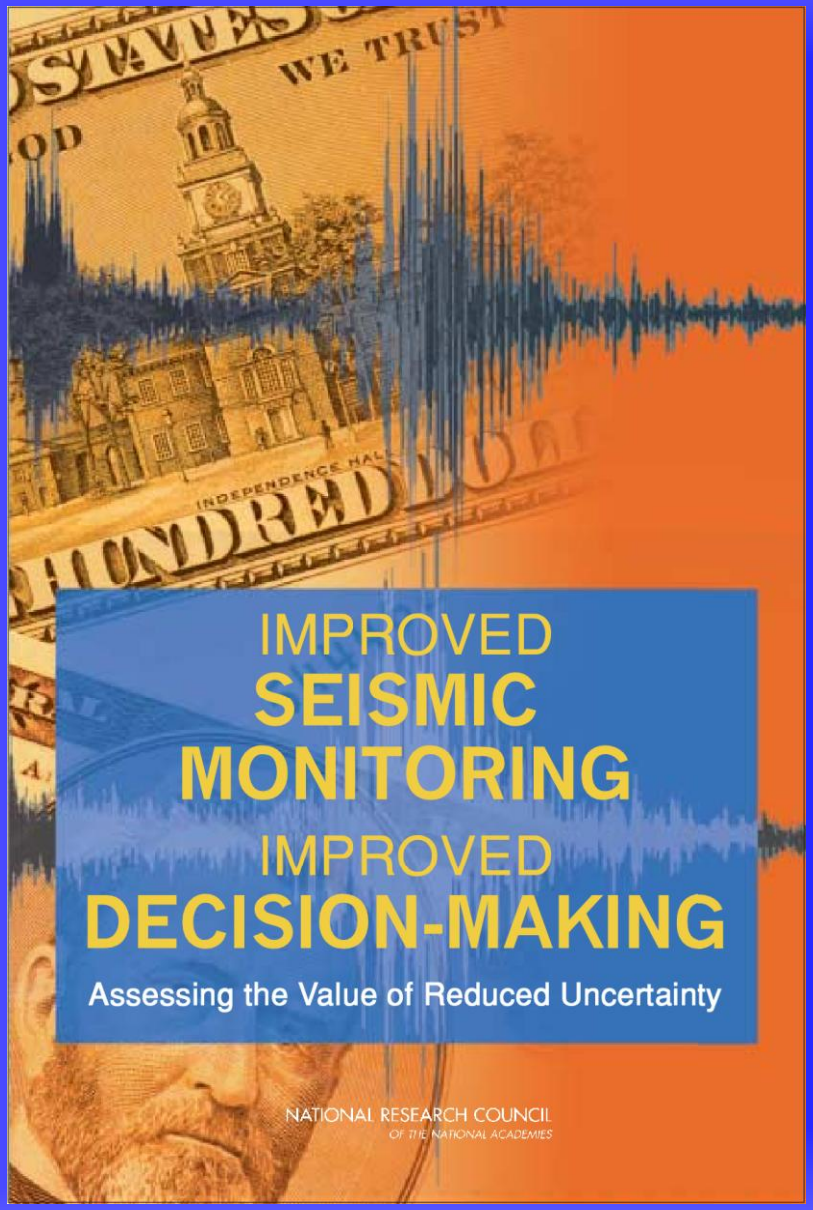

NATIONAL RESEARCH COUNCIL

Committee on the Economic Benefits of Improved Seismic Monitoring

Committee on Seismology and Geodynamics
Board on Earth Sciences and Resources

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Terry Wallace, Los Alamos National Laboratory, NM

Committee on the Economic Benefits of Improved Seismic Monitoring

Statement of Task

Provide advice regarding the economic benefits with particular attention to the benefits that could derive from implementation of the Advanced National Seismic System (ANSS).

- Review the nature of losses caused by earthquakes.
- Examine how improved information could reduce future losses
- Assess the capabilities of existing monitoring networks,
- Describe methods for assessing avoided costs
- To the extent possible, estimate the potential benefits

Seismic Monitoring Systems:

- **Weak Motion**
  - Located in "quiet places"
  - Record seismograms for earthquakes worldwide
  - USNSN, Earthscope, ANSS
- **Strong Motion**
  - Locate in the free-field, in urban settings, and on structures.
  - Record the intensity of the earthquake in terms of acceleration
  - NSP, CSMIP, ANSS

Bottom line:

on an annual basis,

the dollar costs are in the tens of millions &

the potential benefits are in the hundreds of millions.

Potential Losses from Earthquakes -

- Approximately 30% of the population and 50% of the national building stock are located in areas prone to damaging earthquakes; 33% of the building stock is in high or very high seismic risk states.
- Losses include direct physical damage, induced physical damage (e.g., fire, dam collapse, etc.), human impacts, costs of response and recovery, and business interruption and other economic losses.
- Annualized building and building-related losses are estimated to be $5.6 billion.
- A single damaging earthquake could cause losses in excess of $100 billion (e.g., direct losses from the Northridge earthquake were $50-60 billion)

Overview-

- Describe the problem, the current networks, the uses, the cost of monitoring and the extent of losses.
- Describe the contribution that information from seismic monitoring provides for decision-making.
- Describe the economic context for benefit calculation.
- Describe the benefits for improved earthquake hazard assessment and forecasting.
- Describe the benefits for improved loss estimation models.
- Describe the benefits for performance-based engineering.
- Describe the benefits for emergency response and recovery.

Key Findings–

For decision-making:

- –Risk Assessment: Monitoring defines the nature of the risk
- –Risk Perception and Choice: Monitoring affects choices
- –Risk Management: Monitoring leads to alternate strategies

Overall: Increased monitoring will reduce the uncertainty and the ambiguity now embedded in the process

Economic Principles -

- Losses must be evaluated in terms of real resource costs and in terms of prices that reflect their competitive value.
- Benefits are not limited to those activities with markets, but should also include non-market effects
- Future benefits must be discounted to adjust for the "time value of money"
- Flow measures of benefits, such as business interruption losses, should be evaluated over the time period needed to return to the projected normal level of economic activity.
- Benefits should reflect inherent and adaptive resilience at the individual, market, and community levels

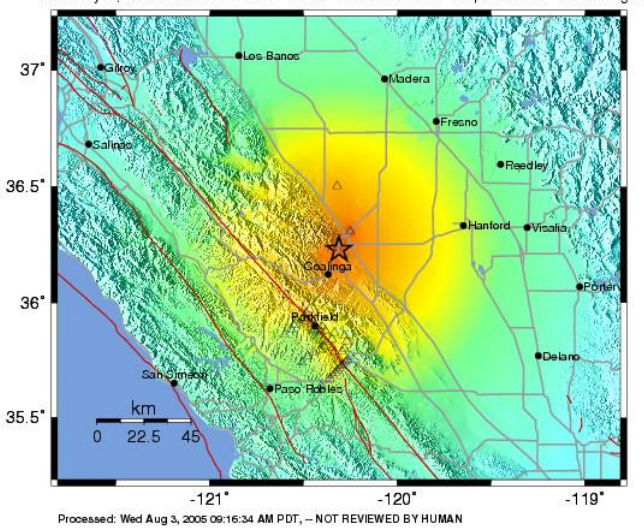
Key Findings -

For improved earthquake hazard assessment and forecasting:

- Predicting ground motion intensity
- Improved Seismic Zonation
- Forcasting
- Predicition

CISN Rapid Instrumental Intensity Map for Coalinga Earthquake

Mon May 2, 1983 04:42:00 PM PDT M 6.5 N36.23 W120.31 Depth: 10.0km ID:Coalinga



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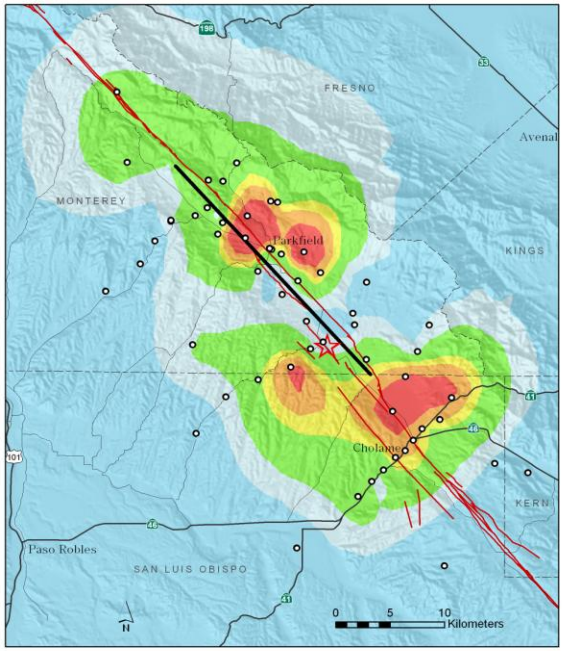
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+



NEAR-FAULT GROUND SHAKING

Parkfield Earthquake of 28 Sep 2004, M6.0

Peak Acceleration (g)

- **> 0.65**
- **0.55 - 0.65**
- **0.45 - 0.55**
- **0.3 - 0.45**
- **0.2 - 0.3**
- **< 0.2**

- Epicenter
- Strong motion station
- Modeled fault
- Fault trace
- State highway
- Local road
- County boundary

CGS USGS OES Caltech UC Berkeley

PGA data from CGS ShakeMap of 10/25/04

Key Findings -

For improved loss estimation models:

- Reduced uncertainty yields reduced premiums and better take up
- Monitoring will provide a more complete description of the seismic event and how different faults behave
- Monitoring will define how the built environment is impacted by different levels of seismic activity

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Key Findings…

For performance-based engineering:

- Links design to the ground motion
- New insights available from every earthquake
- Will yield savings in the cost of construction every day

Key Findings…

For emergency response and recovery:

- Improves response readiness
- Provides real time information for response
- Provides improved data for recovery assistance

Benefit	Buildings Affected	Total Value	Seismic Cost[1]	Rehab. Cost Saved	Annual Savings	Beneficiary
Proof Testing of Instrumented Buildings	300 added by ANSS	$3 billion	$150 million	$75 million	$3 million[2]	Building Owner
Post Earthquake Repair	300 added by ANSS	$3 billion	$315 million	$63 million	$2 million[3]	Building Owner, FEMA
Improved Seismic Hazard Maps	all buildings in seismic zones	$165 billion	$4.9 billion		$49 million[4]	Building Owner
Refined Analysis Techniques	10% of existing inventory	Annual $170 billion	$34 billion	$850 million	$34 million[5]	Building Owner, FEMA
Improved New Construction Procedures	all buildings in seismic zones	$165 billion			$20 million[6]	Building Owner, FEMA
Improved Rehabilitation Procedures	10% of existing inventory	Annual $170 billion	$34 billion	$850 million	$34 million[5]	Building Owner, FEMA
Total Annualized Savings					$142 million	

[1] Seismic Cost is the cost to add appropriate seismic strengthening to a building during repair, rehabilitation, or initial construction.

[2] 50 percent proof tested, saving is from eliminating the need to rehabilitate.

[3] 20 percent less repair costs.

[4] 1 percent reduction in seismic cost.

[5] 5 percent reduction in seismic cost.

[6] 2 percent reduction in seismic loss for 30 percent of the buildings.

Conclusion:

…on an annual basis, the dollar costs for improved seismic monitoring are in the tens of millions, but the potential dollar benefits are in the hundreds of millions.

Recommendation:

The United States should rank arresting the future growth of seismic risk and reducing the nation's current seismic risk as highly as other critical national programs that need persistent long-term attention, and it should make the necessary investment to achieve these goals.

Recommendation:

The integration of HAZUS loss-estimation capabilities and USGS earthquake hazard information should be continued to track the growth of seismic risk in the United States, thereby further reducing the uncertainty.

Recommendation:

After every damaging earthquake within the U.S., data gathering and applied research should be sponsored—as a collaborative activity among the NEHRP agencies—to document how seismic monitoring information reduced uncertainty and provided economic benefits.

Comprehensive reports should be published within one year after the event for short-term benefits, and within 10 years after the event for intermediate- and long-term benefits.

Bottom Line:

Full deployment of the ANSS could substantially reduce earthquake losses and their consequences by providing critical information for land-use planning, building design, insurance, warnings, and emergency preparedness and response.

The potential benefits far exceed the costs—annualized building-related earthquake losses are estimated to be about $5.6 billion, whereas the annualized cost of the improved monitoring is about $96 million (<2% of estimated losses).

Mitigation actions—based on improved information and reduction of uncertainty—would yield benefits several times the cost of improved seismic monitoring.