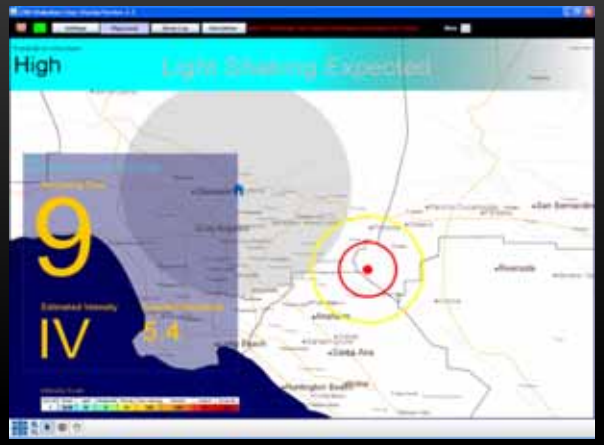


SOCIAL AND BEHAVIORAL ASPECTS OF EARTHQUAKE EARLY WARNING

James D. Goltz Ph.D.
Branch Chief (Retired)
Earthquake, Tsunami and Volcanic Hazards Program
California Office of Emergency Services
National Earthquake Program Managers Meeting
Denver May 21-23, 2014

Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES

WHAT DO THE SOCIAL SCIENCES HAVE TO OFFER
IN DEVELOPING EARTHQUAKE EARLY WARNING SYSTEMS?

- Provide insights from research on human behavioral response to crisis situations, particularly immanent warnings
- Based on research, assist emergency managers and scientists in crafting public education programs to maximize the effectiveness of earthquake early warnings
- Develop warning messages that have the greatest likelihood of triggering appropriate response
- Provide a broad understanding of the social and ideological context in which earthquake early warning will be introduced

HUMAN RESPONSE TO A SUDDEN CRISIS

CONVENTIONAL WISDOM REGARDING HUMAN BEHAVIOR IN A CRISIS

- Myth#1: Most people will panic during the shaking disregarding appropriate response training (e.g. everyone runs outside)
- Myth#2: People will exhibit "shock" becoming passive and require major assistance from response agencies
- Myth#3: Providing a few seconds of warning for an earthquake will only trigger panic, not mitigation and protective actions

The Telegraph

Panic is the main risk when disaster hits

The real danger of the nuclear crisis in Japan is over-reaction in the rest of the world, argues David King.

http://www.telegraph.co.uk/

"It's a good idea in theory, but it might be useless because you don't have that much time to prepare," said a senior journalism major. "At the moment, you panic and forget what to do." – http://www.daily49er.com/news/2014/05/06/long-beach-to-test-early-earthquake-warning-system

THE MEDIA SHARE MOST OF THE BLAME,

BUT MYTHS ARE ALSO PERPETUATED BY:

Scientists, engineers and other professionals speaking outside their areas of expertise

"Fright and panic are such regular effects of strong shaking that they form an established part of all intensity scales. Persons and populations differ according to their previous experience, but only an abnormally cold-blooded person can remain calm when the structures over his head are being damaged and the ground under his feet is shaking so as to destroy the basic feelings of security. The most universal impulse is to run, even when already outdoors" Charles Richter

Intensity scales that attempt to associate human behavior with earthquake shaking

I- IV	Not felt, to slight excitement, few ran outdoors
V	Felt indoors by practically all, outdoors by many –Awakened many, or most. Frightened few--slight excitement, a few ran outdoors.
VI	Felt by all – indoors and outdoors. Frightened many, excitement general.
VII	Frightened all – general alarm, all ran outdoors. Some, or many, found it difficult to stand. Noticed by persons driving motor cars.
VIII	Fright general – alarm approaches panic. Disturbed persons driving motor cars.
IX	Panic general
X-XII	?

BUT 90 YEARS OF RESEARCH HAS DEMONSTRATED:

- Panic rarely characterizes behavior in response to warnings or natural disasters
- Disaster shock affects very few people, most display active adaptive behaviors
- A few seconds to tens of seconds warning of the approach of strong ground motion will not trigger panic
- The biggest challenge is not panic but a “normalcy bias” which delays protective actions
- Rather than shocked incapacity, people who have experienced a disaster are active, assist others
- If properly trained, people will take protective action even with a few seconds of warning

SCENES OF DISASTER RESPONSE

SOCIAL SCIENCE RESEARCH ON WARNINGS REVEALS

- Panic in Reaction to Warning? Research indicates just the opposite—people want to normalize threatening situations. Under reaction more likely!
- Crying Wolf? Social Scientists say that “false alarms” are problematic but organizations vary in tolerance for false alarms
- Warnings to the public most effective when:
  - They are issued as verbal messages in addition to non-verbal signals (e.g. sirens)
  - Warning contains detailed information about the threat and how to respond
  - Is repeated with increasing degrees of urgency over varied channels of communication
  - Accompanied by perceptual clues that validate the danger
- Pronouncements from official sources must be clear, consistent and authoritative

COMPLIANCE WITH WARNINGS ALSO INFLUENCED BY:

- Prior experience with the hazard
- Trust in the organization issuing warning (credibility of the source)
- Extent of prior training and education in response to this hazard

SO WHAT DOES THIS TELL US ABOUT LIKELY HUMAN BEHAVIOR IN RESPONSE TO EARTHQUAKE EARLY WARNINGS?

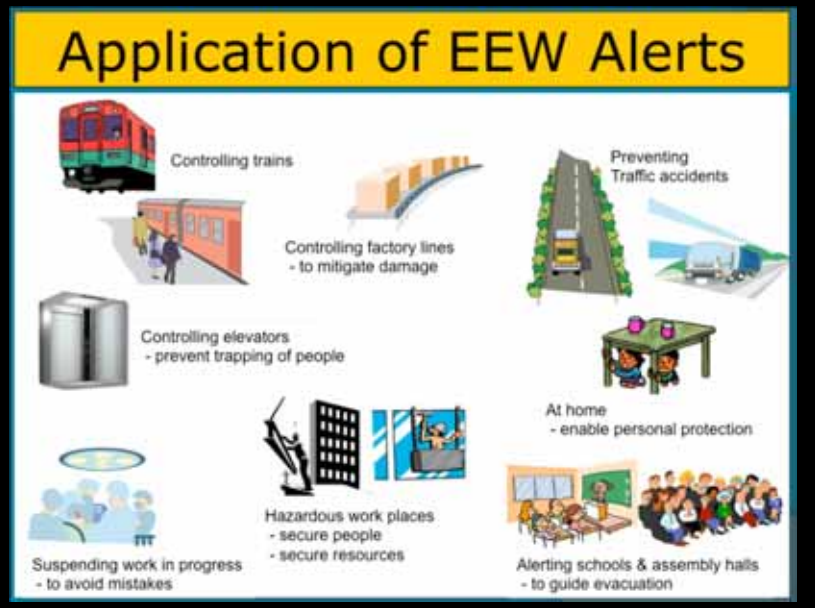
- Trust the ability of people to benefit from training—instinct does not rule human behavior in a disaster
- Warnings of a few seconds, with proper training, can significantly contribute to survival and avoidance of injury in a major earthquake
- A collaboration between physical scientists, engineers, social scientists and emergency managers will maximize the utility of an early warning system

DEVELOPING PUBLIC EDUCATION PROGRAMS FOR EARTHQUAKE EARLY WARNING

HOW CAN EARTHQUAKE EARLY WARNING HELP US SURVIVE A MAJOR EARTHQUAKE?

THE MANY REALMS OF EARTHQUAKE EARLY WARNING

- Can automatically slow or stop trains to avoid derailment from strong ground motion
- Prevent earthquake caused traffic accidents
- Control elevators so occupants are not trapped
- Suspend work in progress to avoid injury or mistakes in hazardous work places
- Alerting people where ever they are to take cover
- Suspend data transfers and save vital data



All of these actions require training and education among potential early warning users!

IN SHORT, EDUCATION FOR EARTHQUAKE EARLY WARNING MUST FOCUS ON TWO THINGS:

- Identify and manage situations in which hazards can be mitigated in a timeframe of a few seconds to a few tens of seconds
  - Slowing trains, programming elevators, raising fire station doors are examples of mitigation
  - Are there others? What about telecommunications, other utilities, financial and other data transfers
- Life safety measures
  - Training people to protect themselves in different situations when an earthquake early warning is received
- Understanding the demographic and social characteristics of target audiences for earthquake early warning will maximize the effectiveness of training and public education

IN CALIFORNIA, LEGISLATION PASSED MANDATING DEVELOPMENT OF AN EEW SYSTEM

- Five committees set up by Cal OES to develop blueprint for an earthquake early warning system
- One of these committees will identify a program of training and education for effective use of an earthquake early warning system
- Kate Long CA Earthquake Program Manager will chair and social scientists will be on the committee

CRAFTING EFFECTIVE MESSAGES

NEW RESEARCH ON MESSAGE LENGTH AND CONTENT

- Interdisciplinary group at the University of Kentucky* looked at the content of EEW messages for a smart phone app
- Preliminary survey results indicated that:
  - Recipients more likely to recall the location of the earthquake if app included a map
  - Intensity of the earthquake best recalled when a numerical indicator used (however some confusion regarding the meaning of the intensity number)
  - A countdown clock was preferred to a static number indicating the number of seconds before the arrival of ground motion
  - No conclusive differences in the effectiveness of voice commands vs. alert signal though recipients suggested that the auditory component be similar to existing warning announcement formats.
  - Male vs. female voice not significant but voice of a well known scientist like Dr. Lucy Jones in southern California would be both reassuring and authoritative
- Next phase of the study will be to develop test messages based on this first phase of the study

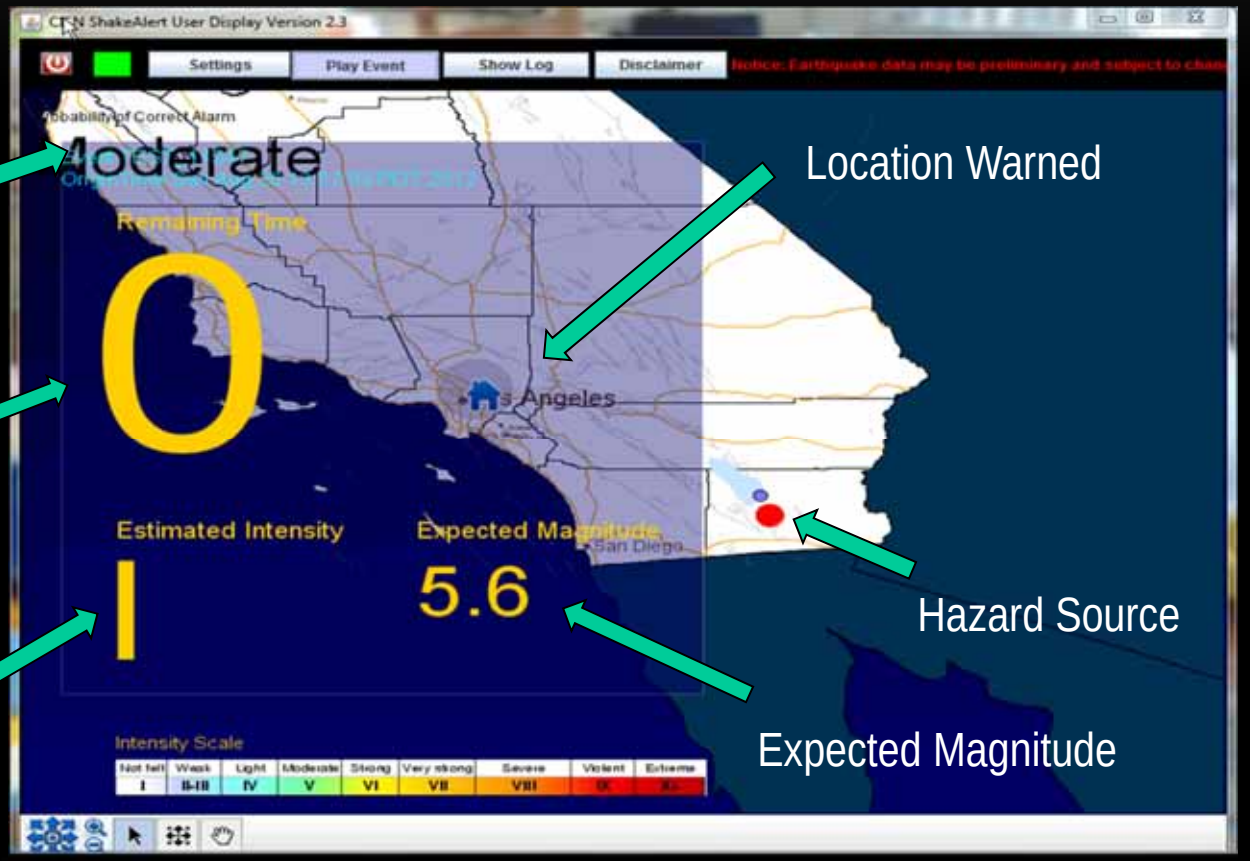
* Deanna Sellnow, Tim Sellnow, Patric Spence, Derek Lane and Nigel Haarstad

RESEARCH WITH A SIMILAR FOCUS ON IMMANENT THREAT MESSAGES FOR MOBILE DEVICES

- Study funded by the Science and Technology Directorate, US Department of Homeland Security
- Objective of the study still in progress: Determine optimized message contents of immanent threat alerts and warnings delivered over mobile communication devices or "Wireless Emergency Alerts" or WEAs.
- Study includes Internet and laboratory experiments, focus groups and "think out loud" interviews
- Preliminary findings:
  - Considered message length as 90, 140 and 1,380 character messages—longer better
  - Current order of content: hazard, location, time, guidance and source. Study found that for shorter messages, improved response obtained by: source, guidance, hazard, location, time. For longer message: source, hazard, guidance, location, time.
  - Locally recognized source promoted understanding, believing and taking protective action
  - Inclusion of map a benefit, ideally containing: areas affected, areas not affected, receiver's location
  - Guidance is the key element in content: tell people exactly what to do and why they should do it
  - Time considerations must be joined with actions: "take cover now or immediately"
  - Visual aspects of warning messages matter: logos, color, font size, italics, use of bullets all may influence message interpretation and response
- These preliminary findings will be followed up in subsequent phases of the study. Investigators also plan to look at emotional response to warning messages, especially the impact of fear on message interpretation and response.

* Hamilton Bean, Michele Wood, Dennis Mileti, Brooke Liu, Jeannette Sutton, Stephanie Madden

SHAKEALERT MESSAGE FORMAT



LEST ANYONE THINK THAT THESE STUDIES JUST REFLECT COMMON SENSE,

CONSIDER WARNING MESSAGES WITH NO SOCIAL SCIENCE INPUT:

WEAK53 PAAQ 020235

TIBAK1

PUBLIC TSUNAMI INFORMATION STATEMENT NUMBER 4

NWS NATIONAL TSUNAMI WARNING CENTER PALMER AK

735 PM PDT TUE APR 1 2014

UPDATES IN THIS MESSAGE INCLUDE NEW OBSERVATIONS.

UPDATES IN THIS MESSAGE INCLUDE REVISED FORECAST INFORMATION.

...THIS IS A TSUNAMI INFORMATION STATEMENT FOR ALASKA/ BRITISH COLUMBIA/ WASHINGTON/ OREGON AND CALIFORNIA...

EVALUATION

* NO TSUNAMI THREAT EXISTS FOR THE AREAS LISTED ABOVE.
* SOME OF THE AREAS LISTED ABOVE MAY EXPERIENCE NON-DAMAGING SEA LEVEL CHANGES.
* SEA LEVEL OBSERVATIONS INDICATE A TSUNAMI WAS GENERATED.

PRELIMINARY EARTHQUAKE PARAMETERS

* MAGNITUDE 8.2
* ORIGIN TIME 1547 AKDT APR 01 2014
  1647 PDT APR 01 2014
  2347 UTC APR 01 2014
* COORDINATES 19.8 SOUTH 70.8 WEST
* DEPTH 6 MILES
* LOCATION NEAR COAST OF NORTHERN CHILE

OBSERVATIONS OF TSUNAMI ACTIVITY - UPDATED

SITE	TIME OF MEASUREMENT	OBSERVED MAX TSUNAMI HEIGHT
PISAGUA CHILE	0102 UTC 04-02	07.6FT
IQUIQUE CHILE	0204 UTC 04-02	06.3FT
DART32401ST CHILE	0011 UTC 04-02	00.8FT
PATACHE CHILE	0006 UTC 04-02	05.6FT
ARICA CHILE	0016 UTC 04-02	04.4FT
MATARANI PERU	0020 UTC 04-02	01.8FT
ANTOFAGASTA CHILE	0027 UTC 04-02	00.9FT
MEJILLONES CHILE	0038 UTC 04-02	02.0FT
DART32412ST LIMA PERU	2355 UTC 04-01	00.1FT
CALDERA CHILE	0050 UTC 04-02	00.5FT
CHANARAL CHILE	0140 UTC 04-02	01.2FT
COQUIMBO CHILE	0125 UTC 04-02	00.4FT
CALLAO LA PUNTA PERU	0158 UTC 04-02	00.4FT

HEIGHT - OBSERVED MAX TSUNAMI HEIGHT IS THE WATER LEVEL ABOVE THE TIDE LEVEL AT THE TIME OF MEASUREMENT.

NEXT UPDATE AND ADDITIONAL INFORMATION

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* THIS WILL BE THE FINAL U.S. NATIONAL TSUNAMI WARNING CENTER MESSAGE FOR THIS EVENT UNLESS ADDITIONAL INFORMATION BECOMES AVAILABLE.

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THE SOCIAL AND IDEOLOGICAL CONTEXT FOR EARTHQUAKE EARLY WARNING

MODELS OF HOW AN EARTHQUAKE EARLY WARNING SYSTEM SHOULD BE BUILT AND OPERATED

Like it or not politics shapes our views of what an earthquake early warning system should look like

ALTERNATE VIEWS OF HOW TO ORGANIZE AND MANAGE AND EARTHQUAKE EARLY WARNING SYSTEM

A Publically Managed System

- Available to all funded by tax dollars
- Based on the existing network with publically funded enhancements
- Managed and operated by scientists and engineers who work for government agencies and/or public universities
- Private sector roles: adapt government issued alerts to the needs of specific institutional sectors, provide seismic instruments and devices to convey warnings

A Privately Managed System

- Available by subscription as a profitable enterprise
- Based on a new private network specifically designed for earthquake early warning
- Managed and operated by science and engineering-oriented private companies
- Public sector roles: train subscribers to use alerts issued by the companies as part of a comprehensive mitigation and preparedness program, pay subscriber fees for those who cannot afford subscriptions

ARGUMENTS FOR A PRIVATE SECTOR SYSTEM

- A private system mobilizes and reaps the advantages of competition and innovation that characterizes the private sector
- Economies of scale would eventually make early warning affordable to everyone and government could subsidize the poorest elements of an earthquake vulnerable population
- The public sector network is designed to provide a great deal of seismic information—a streamlined private sector system would be specifically designed to issue earthquake early warnings only and mitigate hazards associated with this time frame
- Having one government agency in charge of earthquake early warning eliminates competition, reduces opportunities for innovation and results in a stifling bureaucratic “top down” system
- A private system that issues earthquake early warnings already exists in California, so the private sector is not starting from scratch and has an established track record

ARGUMENTS FOR A PUBLIC SECTOR SYSTEM

- Geologic hazard warnings are a “public good.” Public goods are those typically provided as a service of government for all within a given jurisdiction. In short, no one is excluded or denied service.
- It is contrary to the ethos of the US to provide disaster warnings to only those who can pay for them
- Earthquake early warning is a logical extension of existing “real time” information provided by the USGS and university seismic network operators
- Considerable tax dollars have financed the Advanced National Seismic System so there has already been a significant public investment
- Government agencies have considerable protection from liability for potential errors in the system, protection not enjoyed by the private sector
- It makes more sense to have one agency responsible for issuing early warnings than many if they are privately issued

CAN SOCIAL SCIENCE HELP?

MAYBE BY HIGHLIGHTING A HYBRID SYSTEM OR PUBLIC-PRIVATE PARTNERSHIP

- Given the level of public financing of the seismic networks in the US, the relative immunity from liability of high level government officials acting consistently with their mandates, conceptualizing EEW as a public good and having a system that “speaks with one voice” the issuance of EEW by one government agency makes the most sense.
- Private sector roles are necessary and vital to the success of an earthquake early warning system and include:
  - Providing various institutional sectors (e.g. health care, financial services, manufacturing, education, utilities, etc.) with state of the art systems to optimally utilize a warning issued by the USGS or other science agency
  - Develop applications for delivering a warning message via mobile devices
  - Through R&D, produce monitoring instruments, telemetry and software for the detection and communication of data on an evolving seismic sequence.
  - Provide education and training programs for public education and industry specific planning

SUMMARY AND CONCLUSIONS

- The planning environment for development and implementation of an earthquake early warning system is conducive and is not limited in any way by likely adverse or maladaptive human behavior—even to very brief warning time frames

- Social science research has established and continues to provide a sound basis for planning and development of an EEW system and can guide the education of users, inform the messages that are sent and predict the likely outcomes of various strategies for system development

- The convergence of technology and science (including social science) will add another potentially vital life safety and mitigation benefit to our existing set of strategies for reducing the loss of life and property damage from major seismic events