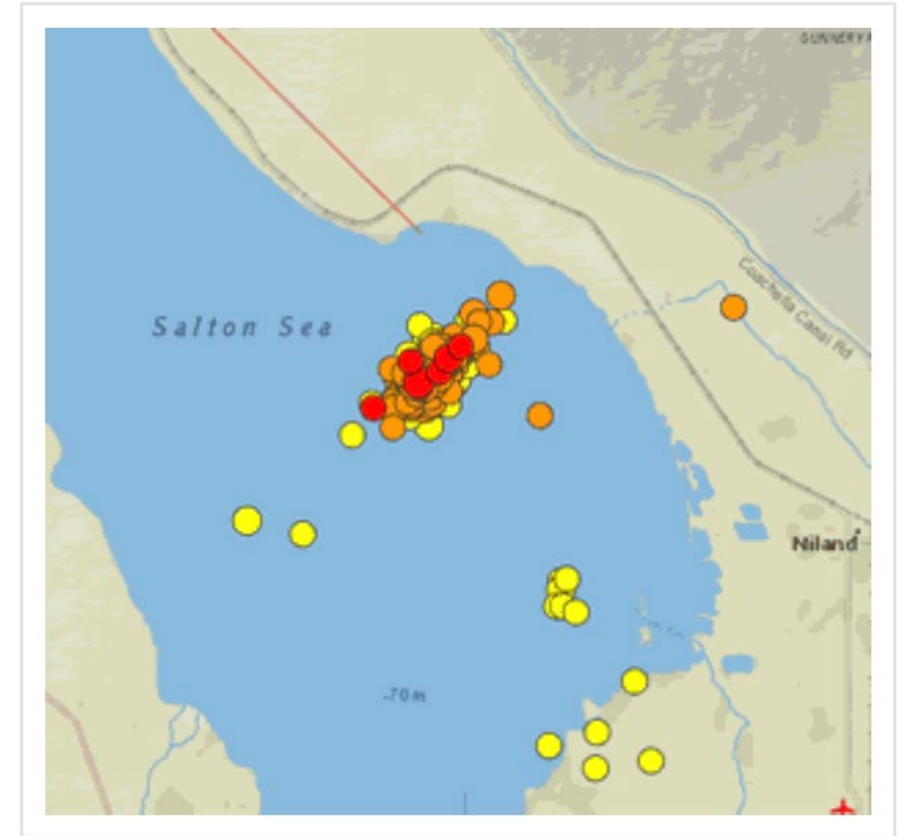


Background of the September 2016 Salton Sea Earthquake Swarm

CEPEC met by teleconference at the request of CalOES at 08:30 on September 27 to discuss and evaluate a sequence 150+ small earthquakes near Bombay Beach.

The swarm was very close to the south end of the San Andreas Fault.

Most of the earthquakes were $M < 2$; but, on the morning of September 26 there was an M 4.3, followed by a second M4.3 and an M4.1 that evening.



Earthquakes in the Brawley seismic zone as of the evening of 09/27/2016.

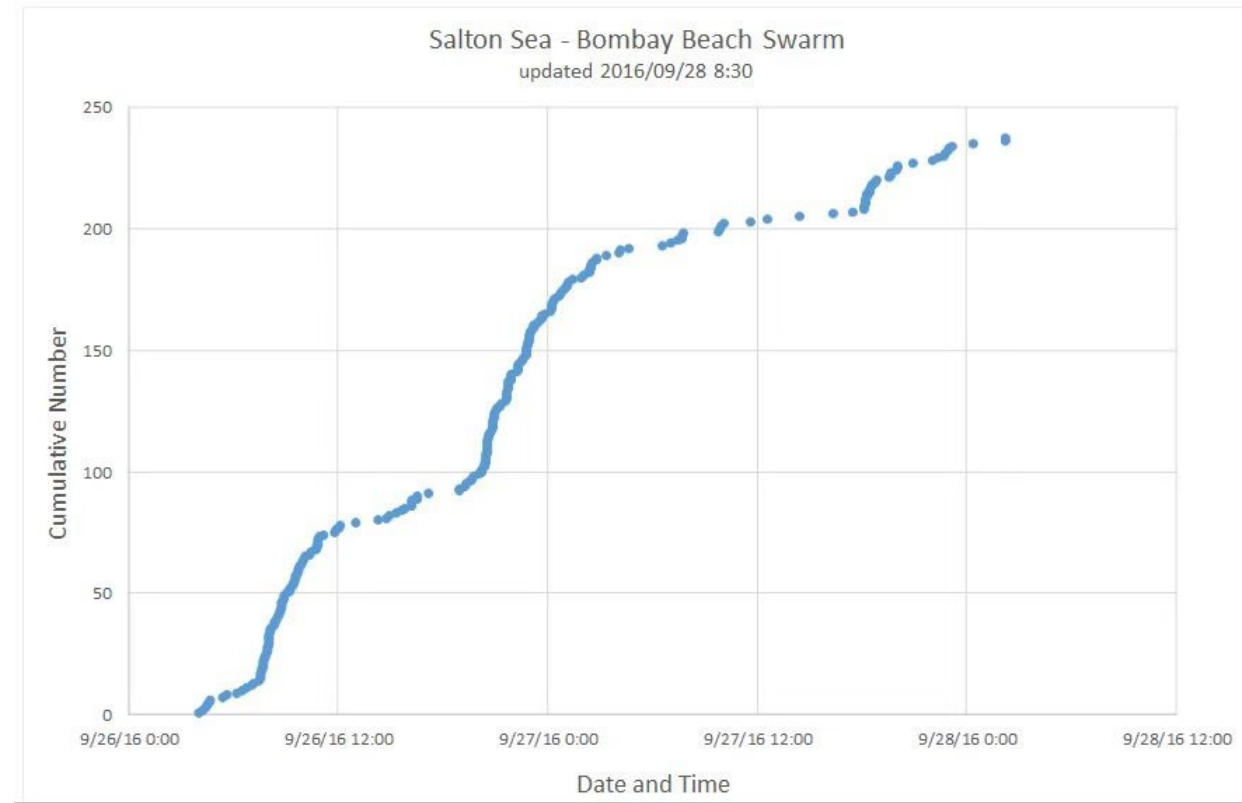
(Figure from "USGS Summary for Swarm Activity Near Bombay Beach")

Background of the September 2016 Salton Sea Earthquake Swarm

The cluster was adjacent to similar clusters in 2001 and 2009, but the proximity to the San Andreas increased concern that this sequence could trigger a large (M7.0+) earthquake on the San Andreas itself.

The last major earthquake on this southern part of the San Andreas occurred over 300 years ago, which led some seismologists to believe that hazard from this segment of the fault is higher than from more recently ruptured segments.

In response to the request from CalOES, CEPEC developed a quantitative range of aftershock/foreshock probabilities.



(Figure from Egill Hauksson (Caltech))

CEPEC response to the 2016 Salton Sea Earthquake Swarm

CEPEC issued the following guidance to CalOES:

“CEPEC believes that stresses associated with this earthquake swarm may increase the probability of a major earthquake on the San Andreas Fault to values between 0.03 percent and 1.0 percent for a M7.0 or larger earthquake occurring over the next week (to 09:00 hrs PDT, Tuesday, October 4, 2016).”

“This probability range is based on several models developed for assessing aftershock/foreshock probabilities within California. CEPEC recommends that local emergency services be advised of the potential for further earthquake activity and that the citizens of the affected regions should maintain a prudent level of earthquake preparedness.”

At the time John Parrish of CGS was Chair of CEPEC, while Duncan Agnew, Tom Heaton, Jim Brune, Rui Chen, Tom Jordan, Morgan Page, and Greg Beroza were all members. A decade later, Page and Beroza are the only members remaining on CEPEC.

CalOES Notice of Earthquake Advisory for areas of Southern California

EDMUND G. BROWN JR.
GOVERNOR

MARK S. GHILARDUCCI
DIRECTOR



Notice of Earthquake Advisory for areas of Southern California:

Following the series of small magnitude earthquakes and the most recent September 26, 2016, magnitude 4.3 earthquake 6 kilometers south of Bombay Beach, Salton Sea, California; the California Office of Emergency Services has conferred with the California Earthquake Prediction Evaluation Council (CEPEC) that includes scientists representing the California Geological Survey, University of California at San Diego, Southern California Earthquake Center at USC, and the U.S. Geological Survey knowledgeable about this seismic region's history and potential. Based on these discussions, the California Governor's Office of Emergency Services advises the counties of:

- Imperial
- Kern
- Los Angeles
- Orange
- Riverside
- San Bernardino
- San Diego
- Ventura

that CEPEC believes that stresses associated with this earthquake swarm may increase the probability of a major earthquake on the San Andreas Fault to values between 0.03 percent and 1.0 percent of an additional earthquake as large or larger than the September 26 magnitude 4.3 earthquake occurring over the next 7 days, until Tuesday, October 4, 2016 at 9:00am.

CalOES Notice of Earthquake Advisory for areas of Southern California

The CalOES Notice stated that they had conferred with CEPEC, and reported:

“that CEPEC believes that stresses associated with this earthquake swarm may increase the probability of a major earthquake on the San Andreas Fault to values between 0.03 percent and 1.0 percent of an additional earthquake as large or larger than the September 26 magnitude 4.3 earthquake occurring over the next 7 days, until Tuesday, October 4, 2016 at 9:00 am.”

The notice included advice about earthquake preparedness, and was signed by CalOES Director, Mark Ghilarducci.

Note that the statement of probabilities released by CalOES differs from that communicated by CEPEC because it refers to the probability of an event “as large or larger than the September 26 magnitude 4.3 earthquake,” rather than CEPEC’s guidance for, “a M7.0 or larger earthquake.”

CEPEC Expressions of Concern

Members of CEPEC expressed concern to John Parrish that the CalOES statement was misleading, and that it put CEPEC in an untenable position because:

- The statement references a smaller earthquake, for which the probability was subsequently calculated to be much larger (the probability of a $M > 4.3$ earthquake was approximately 30%).
- CEPEC reports to CalOES, not the public, yet CEPEC was cited as the source of the probabilities.
- This potentially undermines CEPEC's credibility, which could be critical in its future effectiveness.

This was all playing out during the forecast window and the probabilities decaying with time, so there was a sense of urgency to communicate the correct numbers.

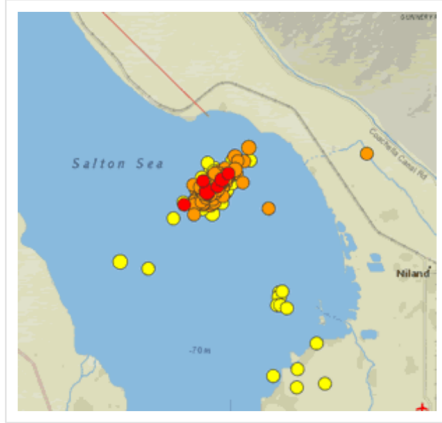
USGS Issued Their Own Summary

USGS Summary for Swarm Activity Near Bombay Beach

An earthquake swarm near Bombay Beach, California, started on 2016 Sept. 26 at 4:03 am (PDT) in the Brawley Seismic Zone, which lies near the southern terminus of the San Andreas Fault.

The swarm includes 142 events so far (as of 26 Sep 2016, 11:31PM PDT) in the magnitude range M1.4 to M4.3. Relocations of these events show that they are occurring in the depth range 4 to 9 km.

The earthquakes are occurring near a set of north-northeast trending cross-faults in the Salton Sea. The cross-faults are part of a fault network that connect the southernmost end of the San Andreas fault with the Imperial fault. Some of the cross-faults are oriented such that they add stress to the San Andreas fault and the San Jacinto fault system when they rupture in small earthquakes like those in the ongoing swarm.



Earthquakes in the Brawley seismic zone as of the evening of 09/27/2016.

Earthquake Swarms and Probabilities

Swarm-like activity in this region has occurred in the past, so this week's activity, in and of itself, is not necessarily cause for alarm.

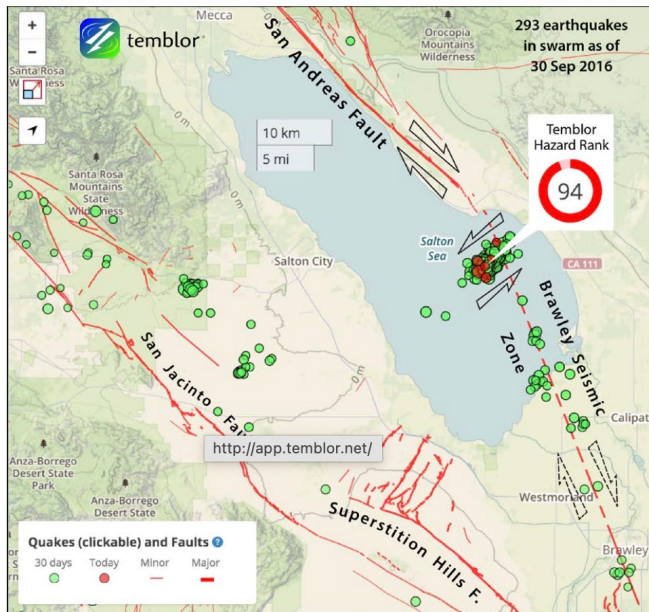
Preliminary calculations indicate that, as of 10:00 am (PDT) Sept. 27, 2016, there is a 0.03%-1% chance (1 in 3000 to 1 in 100) of a magnitude 7 or greater earthquake being triggered on the Southern San Andreas fault within the next seven days through October 4, with the likelihood decreasing over time. This probability range is estimated using several models developed in California to assess foreshock/aftershock probabilities.

The USGS Summary included the forecast probability for an $M \geq 7$ event on the San Andreas Fault, with numbers that were consistent with CEPEC's statement, but inconsistent with that from CalOES

The Media had to Navigate This

California Issues One-week Earthquake Advisory for San Andreas Fault

POSTED ON SEPTEMBER 30, 2016 BY TEMBLOR



29 September 2016 CalOES Earthquake Advisory

According to the California Office of Emergency Services (CalOES), “The California Earthquake Prediction Evaluation Council concluded that stresses associated with this recent earthquake swarm may slightly increase the probability between 0.03 percent and 1.0 percent of an additional earthquake as large, or larger, than the September 26 magnitude 4.3 occurring over the next week.” A full meeting of the Council is now scheduled for Tuesday, October 4.

Temblor Quoted CalOES language



f t m

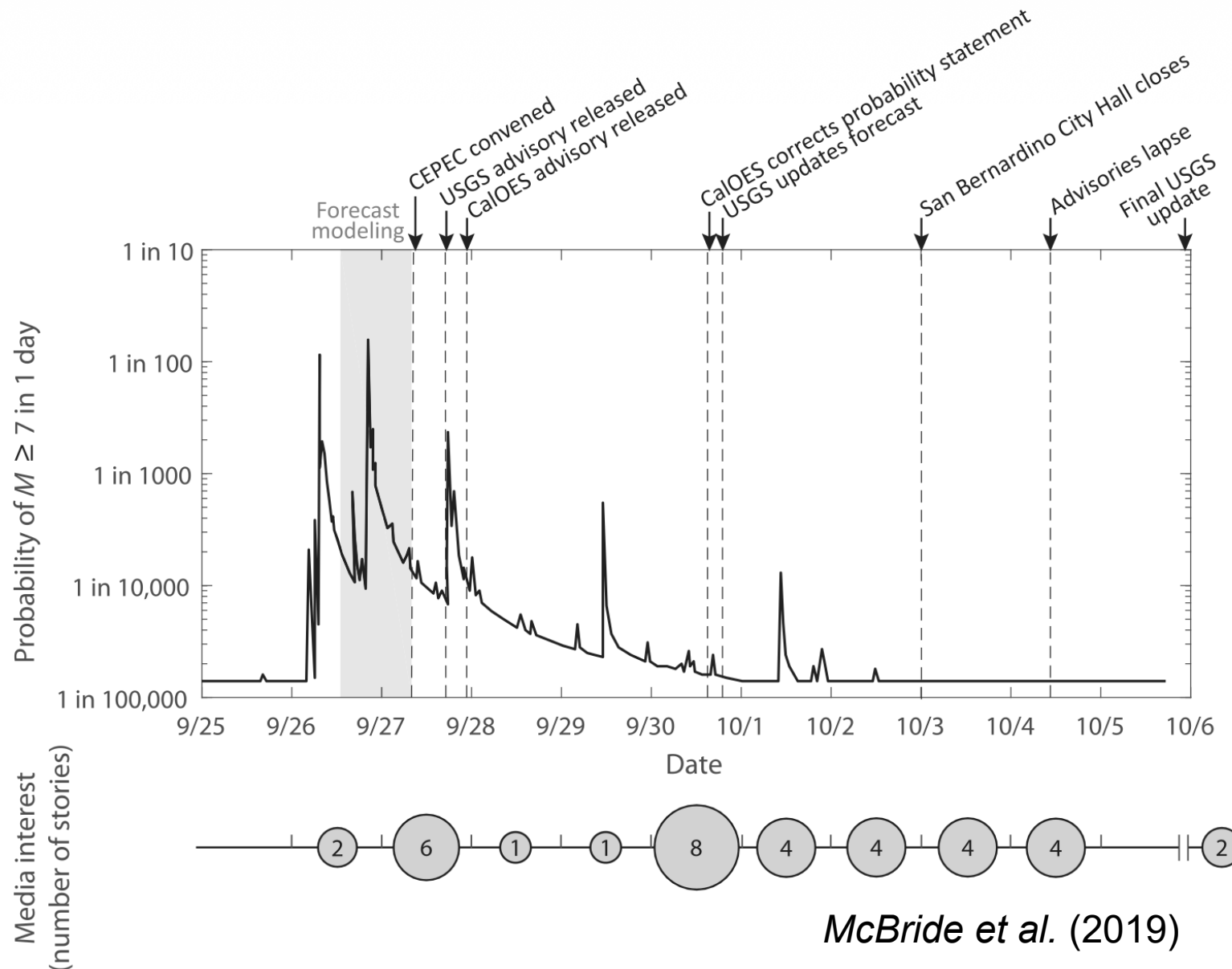
LOCAL / L.A. Now

Risk of big earthquake on San Andreas fault rises after quake swarm at Salton Sea

L.A. Now Quoted USGS language

According to the U.S. Geological Survey, for the seven-day period following Tuesday, the **chances** of a magnitude-7 or greater earthquake being triggered on the southern San Andreas fault are as high as 1 in 100 and as low as 1 in 3,000. The chances diminish over time.

Timeline of Agency and Media Response vs. $M \geq 7$ Earthquake Probability



McBride et al. (2019)

Probabilities

- are dynamic
- decay with time

By the time CalOES issued a correction on September 30, nearly all the probability had expired.

Used as a case study of the challenges in communicating hazard probabilities

#EarthquakeAdvisory: Exploring Discourse between Government Officials, News Media, and Social Media during the 2016 Bombay Beach Swarm

Sara K. McBride^{*1}, Andrea L. Llenos¹, Morgan T. Page², and Nicholas van der Elst²

Abstract

Communicating probabilities of natural hazards to varied audiences is a notoriously difficult task. Many of these challenges were encountered during the 2016 Bombay Beach, California, swarm of ~ 100 $2 \leq M \leq 4.3$ earthquakes, which began on 26 September 2016 and lasted for several days. The swarm's proximity to the southern end of the San Andreas fault caused concern that a larger earthquake could be triggered. Within 1–2 days, different forecast models were used to evaluate the likelihood of a larger event with two agencies (the U.S. Geological Survey [USGS] and the California Governor's Office of Emergency Services) releasing probabilities and forecasts for larger earthquakes. Our research explores communication and news media efforts, as well as how people on a microblogging social media site (Twitter) responded to these forecasts. Our findings suggest that news media used a combination of information sources, basing their articles on what they learned from social media, as well as using information provided by government agencies. As the swarm slowed down, there is evidence of the continued interplay between news media and social media, with the USGS issuing revised probability reports and scientists from the USGS and other institutions participating in media interviews. In reporting on the swarm, news media often used language more generally than the scientists; terms such as probability, likelihood, chance, and possibility were used interchangeably. Knowledge of how news media used scientific information from the 2016 Bombay Beach forecasts can assist local, state, and federal agencies in developing effective communication strategies to respond to future earthquakes.

The public statement released by CalOES initially reported an incorrect magnitude range ($M \geq 4.3$ rather than $M \geq 7$) for the one-week probabilities. With this error, the CalOES statement inadvertently reduced the hazard estimate by a factor of 500. The error was corrected by CalOES in an updated final statement three days later on 30 September (see Supplement A), following a report on the error by the Los Angeles Times.

McBride et al. (2019)

Cite this article as McBride, S. K., A. L. Llenos, M. T. Page, and N. van der Elst (2019). #EarthquakeAdvisory: Exploring Discourse between Government Officials, News Media, and Social Media during the 2016 Bombay Beach Swarm, *Seismol. Res. Lett.* **91**, 438–451, doi: [10.1785/SR20190082](https://doi.org/10.1785/SR20190082).

[Supplemental Material](#)