

Places to Survive:

Assessing potential spaces for earthquake shelters San Francisco Bay Area, CA

Introduction/Background

Earthquake is known as the one of the most destroyable natural disasters. The nature of California lies on the earthquake fault zones increases the risk of occurrence for earthquakes. Back in 2013, the USGS scientists discussed the chances for San Francisco Bay Area to have a magnitude ≥ 6.7 is 62% in the next 30 years (Earthquake Hazards of The Bay Area Today, 2017). The San Francisco Bay Area contains nine counties - Alameda, Contra Costa, Marin, NAPA, San Francisco, San Mateo, San Francisco, Santa Clara, Solano, Sonoma. Multiple major cities including San Francisco, San Jose, Oakland and NAPA etc. specifically choose San Francisco Bay Area because this is an urban area; the population density is greater than the most parts of California (except those major cities in the southern parts of California). Thus, it is an important issue to find out the places that fit the criteria to be an emergency earthquake shelter place.

This project will use GIS methods to access potential shelter places for earthquakes. It will evaluate specifically which nursing homes in the San Francisco Bay Area are potential shelter places for the residents around within driving distance. It is crucial to illustrate the possible options to the residents from the area. What's even more important is planning ahead before the disasters happened. Assessing based on the data provided from previous earthquake and plan more suitable places can help us learn a lot in order to create more efficient rescue plans (Anhorn, J and Khazai, B., 2015). This project will specifically answers the questions like "which nursing homes should I go to near my area of living?"



Figure 1. Bay Area Fault Zones and MMI

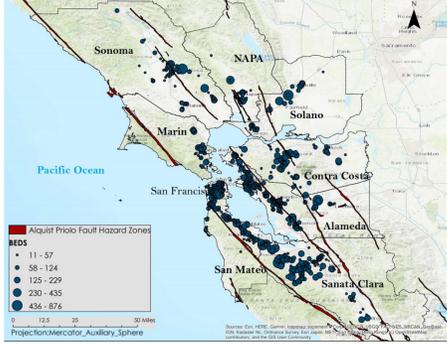


Figure 2. Nursing Homes In Bay Area

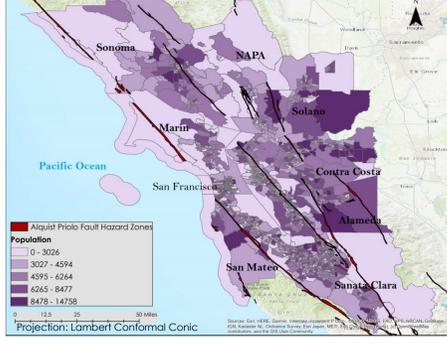


Figure 3. Census 2018 Bay Area

This Earthquake basic data layers from association of Bay Area government Resilience Program (figure 1) indicates the Alquist Priolo Fault Zones specifically in Bay Area and the MMI showed the magnitudes for previous earthquakes. From the figure, areas that lie right above the fault zones are the higher risk places and this is one of the criteria to determine the potential places later one - avoid these areas.

This Nursing Homes data layer from Homeland Infrastructure Foundation-Level Data (HIFLD) (Figure 2) illustrates the locations for nursing homes in the U.S. Data extraction was required to just focus on the Bay Area facilities. They are classified by natural breaks for five groups based on the "Bed" account. They will be evaluated for potential places.

This 2018 U.S. census tract data layer from US. Census Bureau and Tiger/Line (figure 3) provides information like population estimates for the state of California by counties. Even though this is a "2-year-old data" set but it's adequate enough to present the current population estimates.

Results

The final map indicates the locations of nursing homes that fit the criteria. I found that there are more nursing homes that fit criteria close to major cities I mentioned before. In counties like Sonoma, Contra Costa and Alameda, there were not many nursing homes that have greater or equal to 150 beds/population. Most of the nursing homes located on the areas that used to have a magnitude of 8 or 9 earthquakes, this means these places are even more crucial (Figure 5).

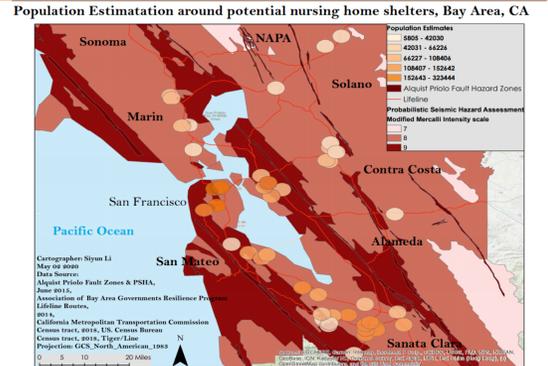


Figure 5. Assessing potential shelter places in Bay Area

Nursing Homes	Population around	Bed Counts
SEQUOIAS SAN FRANCISCO (THE)	323444	400
SAN FRANCISCO TOWERS	314559	350
VINTAGE COVENTRY	306267	210
KINDRED TRANSITIONAL CARE AND REHABILITATION - TUNNELL CENTER	304642	180

Table 1. Nursing homes with the largest population around & bed counts

On the other hand, nursing homes with less population around have more bed counts. For instance, the Stoneridge Greek Pleasanton had only 7125 population estimates live around but the nursing homes have 838 bed counts. (Table 2).

As for total population within each buffer area, the top 4 places that have the most population estimates around the picked nursing homes are in San Francisco and Santa Clara counties. With a huge amount population live around the chosen nursing homes, however, the bed counts/population of these nursing homes are limited. For example, the Kindred Transitional care and Rehabilitation - Tunnell center only had 180 beds but with 304,642 population estimates around (Table 1).

Nursing Homes (Least population estimates)	Population around	Bed Counts
BURLINGAME LONG TERM CARE D/P SNF	5805	281
STONERIDGE CREEK PLEASANTON	7125	828
LOS GATOS MEADOWS	22328	229
BROOKDALE FAIRFIELD	23370	250

Table 2. Nursing homes with the least population around & bed counts

Methodology

The methods I used for analyzing the potential shelter places are described in the flow chart on the right (Figure 4). Firstly, I selected the nursing homes that have beds/population more than 150 because I acquire some larger scale of nursing homes to be potential shelter places. Next, I used select by location to find the nursing homes that are at least 2 miles from the fault zones. Thirdly, I made a 2 mile buffer around each picked out nursing homes. Then, I used the 2 mile buffer layer and the lifeline routes layer to select the nursing homes that crossed by the lifeline routes. The reserved nursing homes are easier to access than the ruled out ones due to convenient transportations. After this, I used the layer from the previous step and with the census tract 2018 data layer and to make a join and summarized the population attributes by calculating the sum for each buffer zones.

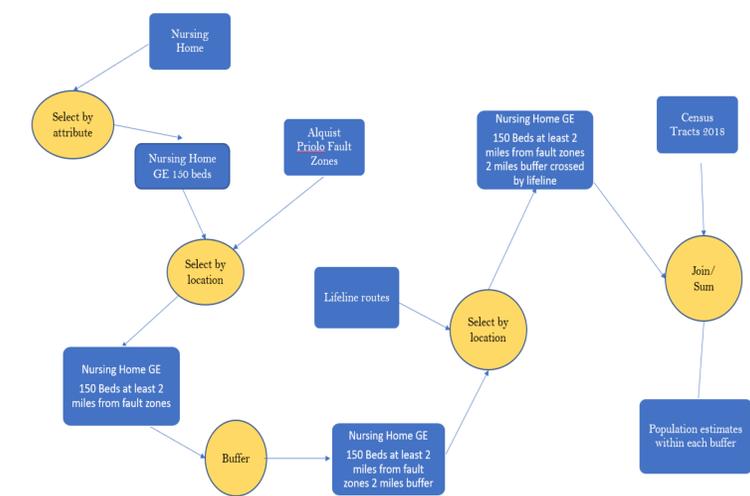


Figure 4. Methods flow chart

Discussion/Conclusion

The 51 selected nursing homes could be possible options as shelter places for earthquakes. The reason I chose out the nursing homes as potential shelter places include these. First, nursing homes are good shelter place since they have a holistic medical team already; this meets one of the criteria discussed in the study by Kilci F, et al. In addition, all of the nursing homes crossed by lifeline route, this means the accessibility will not be a problem for people around to go to the designed shelter places. Limitation for my analysis including I currently use "bed counts" as the assessment to determine the scale of the nursing homes but this is limited. Even though the nursing homes do not have equivalent beds for a huge population group, there are alternative ways to solve this. In deed, future analysis is needed. In future analysis, I should acquire information like, areas for each nursing homes to check if they are capable for accommodate huge groups. My results can be used for city planning and

References

Anhorn, J. and Khazai, B., Open space suitability analysis for emergency shelter after an earthquake Natural Hazards and Earth System Sciences, Volume 15, 2015, Pages 789-803, doi/10.5194/nhess-15-789-2015, https://www.nat-hazards-earth-syst-sci.net/15/789/2015/
 Earthquake Hazards of The Bay Area Today. (2017). Retrieved May 2, 2020, from https://earthquake.usgs.gov/earthquakes/events/1906calif/virtualtour/modern.php
 Kilci F, Yetis Kara B, Bozkaya B. Locating temporary shelter areas after an earthquake: a case for Istanbul. Research database of Sabanci University, Available: http://research.sabanciuniv.edu /23507/

Data Source:

Figure 1-Alquist Priolo Fault Zones & PSHA, June 2015, Association of Bay Area Governments Resilience Program
 Figure 2-Nursing Homes, 2019, HIFLD
 Figure 3-Census tract, 2018, US. Census Bureau & Census tract, 2018, Tiger/Line
 Figure 5-Lifeline Routes,2014, California Metropolitan Transportation Commission