



Unit 1 – “If an earthquake happens in the desert and no one lives there, should we care about it?” [How are man-made infrastructure lifelines affected by earthquakes?] – Student exercise

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1.1 Introduction

Unit 1 is the introductory exercise for this module and it is intended to provide the societal context for the importance of studying faults and the earthquakes they sustain.

We shall explore how earthquakes can impact and disrupt the infrastructure that human populations depend upon. The first step in this process is to consider what types of infrastructure exist are necessary to support modern cities. Many critical infrastructural elements take the form of ‘lifelines’ – the human-built means of transporting resources that sustain life, such as aqueducts, power lines, fuel pipelines and transportation links.

Local populations in earthquake-prone regions may have some awareness of the vulnerability of such elements in their midst, but in many cases key infrastructure lifelines traverse large distances away from population centers, through areas where they may also be susceptible to damage by earthquakes. For example, a significant proportion of the water supply for the city of Los Angeles in California crosses several active faults, including the San Andreas, on its path through the Mojave Desert. An earthquake on any of those faults could have a significant impact on a large regional population, 100 miles away or more.

Infrastructure can be damaged in several different ways in earthquakes. The surface offset due to faulting can shear and break fault-crossing structures, but is by no means the only or most important mechanism – liquefaction of water-saturated soils, and amplification of shaking by soft soils can cause damage to structures located away from faults; these effects can be anticipated through mapping of the quaternary geology. The ability to recognize and evaluate the potential for damage to key infrastructure, near or crossing faults can be used, in turn, to classify, and ultimately predict the most and least likely locations for damage, and be used to make suggestions to minimize impacts should an earthquake occur.

You are provided with: Google Earth kmz files of example infrastructure elements, active quaternary faults and surface geologic maps, for several regions with significant local earthquake hazards. The instructor will guide you as to which region you should focus on.

1.2 Infrastructure damage and disruption by earthquakes

Detailed below are a series of tasks designed to encourage you to reflect on the infrastructure needs of modern society, how these may be vulnerable to damage in earthquakes, and what the possible consequences of that may be for society.

Task 1. Considering infrastructure types and vulnerabilities

- A. Start by creating a ranked list of the expected societal support infrastructure (e.g. water, electricity, fuel, transportation) for a city of moderate size (>250,000), which may be at risk when an earthquake takes place.
- B. Once different resources have been identified, determine the infrastructure required to provide the various resources, paying particular attention to the type of service provided (e.g. transportation, water supply) and geometry (e.g. linear infrastructure such as a pipeline or aqueduct or a point location such as a power plant) of the specific infrastructure. Think about how each type of infrastructure could be damaged by earthquakes, what the magnitude of the possible damage could be and the length of time required to repair the damage, and note these down.
- C. State how the loss of this resource would impact people. This will develop an appreciation for the magnitude of risk/threat imposed by the loss of these resources to individuals and the society in general.

Task 2. Creation of a risk map

- A. Create a map that depicts the locations and geometries of the infrastructure and the location of any known faults in your specific region of interest. You are already provided with some KMZ file examples of infrastructure and geological conditions, but you should supplement these with Internet search results. Google Earth resources (satellite, road maps, street view, important local features) are another good way to delineate infrastructure geometries, types and locations.
- B. Create a summary table to accompany the map, listing resource types, infrastructure geometry, time scale for disruption, and repair time. Include source citations for the information as appropriate.

Task 3. Develop an earthquake damage scenario

- A. Imagine a scenario that describes the aftermath of a major earthquake in your region of interest. Describe the potential for damage/loss associated with each category of infrastructure elements following the earthquake, and rank them from most important to least important in terms of potential negative human/societal impacts. Specifically state for each when the damage will occur and for how long the damage/interruption of a particular resource will persist.
- B. Include in the scenario comments about impacts associated with strong ground motion (i.e. shaking) and those stemming from secondary effects such as liquefaction, fires, landslides, and tsunamis.

1.3 Project Report

Write a short report (2–3 pages of text) describing your findings. Include:

- Your map of infrastructure risk
- Your table of vulnerable infrastructural elements
- Your earthquake damage scenario
- Citations for any additional data sources you use
- An appropriate introduction
- Conclude with a personal reflection on how your view of how an earthquake might affect a city's life-supporting infrastructure has changed as a result of completing this exercise.

The grading rubric below shows the characteristics of a good report.

Component	Exemplary	Basic	Nonperformance
Societal Support Infrastructure (4 points)	4 points: Three-five examples of Societal Support Infrastructure including the students reflections on how their understanding of the complexity of infrastructure damage has changed	2-3 points: Characteristics of a 4-point response but only two or three examples. AND/OR minor conceptual errors and limited reflection comments.	0-1 point: One example labeled with major conceptual errors. AND/OR Processes are labeled but not explained. AND/OR No physical processes labeled on diagram. No reflection comments.
Evidence of Data Collection (4 points)	4 points: An equal or greater number of resources documented with proper citations	2-3 point: Lesser numbers of resources documented	0-1 point: Few resources documented and no documentation
Creation of a Map Display (6 point)	6 points: Creation of a map with accurately positioned overlays of infrastructure with clear legend and explanation	3-5 points: Map has been created with minor errors and may not include legend and explanations	0-2 points: Map is of poor quality and provides a inaccurate portrayal of infrastructure
Hazard Scenario (6 point)	6 points: Creation of a organized hazard ranking with a clear logical discussion of the criteria	3-5 points: Scenario lacks organization with ambiguous hazard ranking with minimal discussion of the criteria	0-2 points: Scenario is of poor quality and provides an inaccurate portrayal of infrastructure hazard risk