**EOSC114 Homework: Earthquakes** *(See footnote for an important copyright notice[1])*

**Introduction and Learning Goals:** Why reading assignments in this course? Good question – please see the page provided in Canvas called "*Introduction to all our reading assignments*". More specifically, here are learning goals for this exercise. Completing this assignment will help you improved your abilities to:

1. Identify *hazards* to communities in North America's Pacific North West that are caused by earthquakes.
2. Relate those specific hazards to corresponding *geological processes*.
3. Judge the importance & costs of *mitigation strategies* based on the likelihood of anticipated *consequences*.
4. Characterize a scientific reading in terms of its type, reliability of sources and the authors' intent.
5. Characterize the claims made by authors in terms of arguments and various types of supporting evidence.

**Instructions. REVIEW THESE CAREFULLY; DON'T MAKE GUESSES ABOUT YOUR TASKS**

Today's reading is a Pulitzer Prize winning article published in the New Yorker July 20, 2015. Several different types of readings will be assigned later in the course.

1) First skim all questions to find out what to expect
2) Find the article online at http://www.newyorker.com/magazine/2015/07/20/the-really-big-one
3) Complete the worksheet during or after reading the article
4) THEN, after you have completed the worksheet, go online to our course website to submit your work.
   a) Time available for online submission is limited. Do the reading & worksheet BEFORE going online.
   b) Online questions are automatically gradable versions of SOME of these worksheet questions.
   c) Each student will get a different sub-set of these questions.

5) **Important notes**
   a) **Regarding older versions of eosc114 exercises**: This homework exercise AND its online data entry questions are *different from* earlier versions of eosc114 homework[1].
   b) THE MOST COMMON ERROR is not reading ONLINE questions carefully. Their order may differ from the work-sheet, answer options are randomized, AND each student gets a different **subset** of questions. Please work online carefully, with your worksheet beside you.
   c) Working with colleagues on homework is OK, but copying the work of others is cheating and will not help you succeed. See the Code of Conduct on our course's Canvas website and UBC's strict rules regarding academic integrity at http://www.calendar.ubc.ca/vancouver/?tree=3,54,111,959.[1]
   d) Note there may be one or more questions about this assignment in future tests, quizzes or exams.
   e) Questions have checkboxes instead of numbers to avoid confusion with different numbering online.
   f) Please recall this course has 1st yr students in non-science disciplines, 4th yr science students, and everyone in between. Some tasks may seem "easy" for some students but will be challenging for others.

**Step 1, processes described by the article**

☐ What was the estimated cost of the 2011 Tohoku earthquake according to this article? Enter your value as a number without units or words. _____

☐ What is the maximum magnitude that might be anticipated for the Cascadia Subduction Zone, or CSZ (enter as a value such as 5.6). _____

☐ According to the article, a full release will result in a predicted maximum height of the tsunami wave of more than _____ metres (convert from feet given in the article, to metres).

☐ According to the article, a full release will result in a predicted tsunami wave speed of "more than" _____ kilometres per hour (convert from miles per hour given in the article).

The article gives a range of values for the elevation in millimeters that North America's western edge is **bulging upwards** each year as a result of pressure from the Juan da Fuca plate.

☐ Minimum amount of bulging each year in units of METERS per year? _____ (Convert millimeters to meters!)

☐ Maximum amount of bulging each year in units of METERS per year? _____.

☐ Average amount of bulging each year in units of METERS per year? _____.

☐ How many years have passed between 2017 and the last known major CSZ earthquake? _____ years.

Given these values, if a CSZ earthquake occurred in 2017, how far would the western edge of North America have **dropped down** after all that bulging was "released" by that earthquake? NOTE: the article says "*…will drop by as much as six feet and rebound thirty to a hundred feet to the west…*" Do NOT use these values – use values found in questions above.

☐ Minimum total amount of sinking if a CSZ earthquake occurred in 2017? _____ meters (not *millimeters)*.

☐ Maximum total amount of sinking if a CSZ earthquake occurred in 2017? _____ metres.

☐ Average total amount of sinking if a CSZ earthquake occurred in 2017? _____ metres.

☐ Certain types of seismic waves were discussed in the article. Which type was not discussed in the article?

- surface waves (of various types including Love waves, Raleigh waves, etc.)
- compressional waves
- shear waves

☐ Which type of seismic waves were characterized in the article as "not very harmful, but potentially very useful"?

- surface waves (of various types including Love waves, Raleigh waves, etc.)
- compressional waves
- shear waves

☐ Which part of the Pacific Northwest is not discussed much in this article and not included in the FEMA (Federal Emergency Management Agency) reports?

- Southern British Columbia
- Northern Washington State
- Southern Washington State
- Northern Oregon
- Southern Oregon
- Northern California

☐ Imagine a large tsunami has occurred and Pachena Bay (now the campground) needs help. Supplies are flown to the international airport near Victoria. Which town has the most reasonable combination of short distance for trucking supplies from Victoria airport and then a reasonably short distance for subsequent helicopter air-lift into Pachena Campground? (Hint: In google maps, search for "Pachena Campground" to find the correct

starting point. Steps for using google maps “measure distance” facility are outlined at https://support.google.com/maps/answer/1628031?co=GENIE.Platform%3DDesktop&hl=en

- Port Alberni; • Courtenay; • Nanaimo; • Vancouver; • Port Renfrew

☐ According to this article, what information led to understanding the impact on the community at Pachena Bay (now the campground) due to the last great CSZ earthquake?

- Analysis of sea floor core samples.
- Dendrochronology of trees in the "ghost forest".
- Long-term records of tsunami recorded in Japan.
- Oral history of local first-nations communities.
- Computer-based modelling of the seismic behavior of the subduction zone.

☐ Consider the sequence of discoveries that led to understanding of CSZ earthquake history and severity. Put this list of information in order from 1=earliest or oldest to be established to 6=most recently. All are in the article but somewhat "buried" within the narrative starting around paragraph 19.
**NOTE the order of these discoveries or observations is NOT the order in which the authors discuss them. See the dates, and think logically.**

_____ Dendrochronology on trees in the ghost forest reveal all trees died at once.

_____ A chief of the Huu-ay-aht First Nation tells the broader, non-indigenous community about a devastating event experienced by Pacific Ocean coastal communities many generations ago.

_____ A tsunami with no apparent cause is observed and recorded in Japan.

_____ A CSZ mega-quake determined to have occurred in 1700 is matched to Japan’s historical record of an orphan tsunami.

_____ Sea-floor coring yields a detailed 10,000-year history of CSZ earthquakes.

_____ Discovery of a “ghost forest”.

**Step 2, consequences & mitigation**

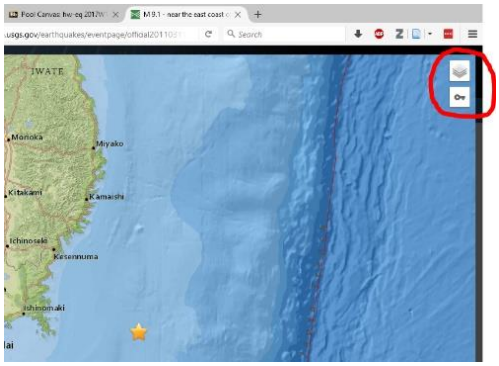
☐ Given the first-person experiences recounted by seismologist Dr. Goldfinger, what Mercalli intensity level did the city of Kashiwa experience due to the Tohoku earthquake? For the definition of intensity levels, see the USGS website https://www.usgs.gov/media/images/modified-mercalli-intensity-mmi-scale-assigns-intensities Circle one option:

• I to II • III to IV • V to VI • VII to VIII • IX to X

☐ What is one example of information from the text that helped you draw this conclusion? Answer in one sentence with your own words.
>

☐ From the description of what it was like to be outside for 4 minutes (article’s first 8 paragraphs), what did you find most compelling as a description of how frightening such an event might be? Write using your own words.
>

Check your estimate of Mercalli intensity level using data provided on the USGS earthquake event page. First go to the website http://earthquake.usgs.gov/earthquakes/eventpage/official20110311054624120_30#dyfi.
*Follow these 5 steps to set up this figure:*




i. Click the map to open an interactive map. **Scroll or +- keys** to zoom in/out. Kashiwa is 32km north-east of Tokyo.

ii. Add/remove **intensity data** as coloured triangles via the layers icon top right, and click "ShakeMap Stations" (see two circled items in the map figure to the right).

iii. **Click any triangle** to see its details.

iv. Move your mouse to see latitude/longitude of the pointer as numbers at bottom left.

v. Find the latitude/longitude location of Kashiwa.

☐ Latitude of Kashiwa _____ degrees North (no words, just numbers)

☐ Longitude of Kashiwa _____ degrees East (no words, just numbers)

☐ Now, based on measurements listed at triangles nearby, what value on the Mercalli scale is most appropriate for Kashiwa? _____.

☐ What were the minimum ____ and maximum ____ intensity measured within a region less than 40 km from the city of Sendai?

**Step 3, characterizing the article** (Point values for T/F questions are 0.5 each)

Information about any field of expertise can be obtained from many sources, with various degrees of reliability. In this section we consider the author's intentions, the types of sources used to support their arguments or "story", and how evidence was used in those arguments. Please Review "primary", "secondary" and "tertiary" sources at: http://scwrl.ubc.ca/student-resources/finding-identifying-and-citing-sources/identifying-different-types-of-sources/.

For each "characteristic" of the article we've read select either true or false. (During online submission, watch carefully to ensure you are answering each question correctly - they may be offered in a different order.)

☐ Our article was written by the author(s) mainly to present their own previously unpublished new developments or discoveries. **True / False**

☐ The central message of our paper was based predominantly on work already presented in earlier publications or other forms of communication. **True / False**

☐ Our reading is mainly targeting a general non-scientific audience. **True / False**

☐ The content in our reading is presented in a non-technical manner, **without** presenting a complete "chain of evidence" using formal references and citations? **True / False**

☐ This article is published in a peer reviewed journal (disregarding comments from an editor). **True / False**

☐ The main purpose or context for this reading is to . . . (Hint: consider where or how it was published.)

- offer social commentary to any reader.
- provide news for the general public.
- explain some scientific matters to the general public.
- provide information for a person or organization who requested it.
- present and discuss recommendations about scientific priorities in the peer-reviewed literature.
- communicate new scientific methods, procedures or discoveries to experts in the subject.

☐ Now, based on your choices above and the summary about source types referred to above, what kind of reference is our article best described as?

• primary • secondary • tertiary

What types of **sources** were used by the author(s)?

☐ One or more citations of primary or secondary sources were included in a reference list. **True / False**?

☐ A bibliography including resources NOT cited in the article was included. **True / False**?

☐ One or more citations of tertiary sources were included in a reference list. **True / False**?

☐ One or more direct quotes from named experts were used by this author to support or justify arguments. **True / False**?

☐ Work of experts was referenced in the writing but not cited in a reference list. **True / False**?

☐ One or more direct quotes from "non-experts" were used as sources by this author. **True / False**?

What **writing strategies** were used in this article? (On Canvas watch carefully to ensure you are answering each question correctly - they may be offered in a different order.)

☐ Assertions and arguments were supported by evidence based on observations, measurements or experiments done by scientists <u>other</u> than the author(s); **True / False**.

☐ Assertions and arguments were supported by evidence based on scientific observations, measurements or experiments done <u>by the author(s)</u>; **True / False**.

☐ Narrative or personal stories were incorporated into the article; **True / False**.

☐ The author(s) targeted human emotion as part of their writing strategies; **True / False**.

☐ Descriptions of "aesthetic" aspects like scenes, views and impressions were included; **True / False**.

☐ The author(s) identified at least some uncertainties, incomplete aspects or needs for further work; **T / F**.

An essential characteristic of scientific writing is that authors will make (or state) claims and support those claims using arguments. Each argument will consist of logic and reasoning that depends upon reproducible observations, evidence and data.

☐ *"Ocean bottom cores contained layers of deposits from undersea landslides."* The most reasonable way of describing this statement paraphrased from our article would be as …

i. an observation or quantity measured with instruments.
ii. an estimate based on calculations using parameters and assumptions that could be varied to yield a range of values
iii. a conclusion, theory or 'understanding' that is well established, based on a variety of consistent observations and/or experiments and logical inferences.
iv. A suggested explanation that was (or is) not well established by a variety of observations or experiments.

☐ *"Tectonic plates are those slabs of mantle and crust that, in their epochs-long drift, rearrange the earth's continents and oceans"*. The most reasonable way of describing this statement in our article would be as… ____ (Same options)

☐ "*Yamaguchi took samples of the cedars and found that they had died at the same time"*. The most reasonable way of describing this statement in our article would be as … ____ (Same options)

☐ "*Trees of the so-called ghost forest on Washington's coast died slowly as sea water gradually rose*." The most reasonable way of describing this statement paraphrased from the article would be as … ____ (Same options)

☐ Which one of these statements most clearly articulates the <u>overarching</u> claim of this article?

- We (humanity) know enough about mega-quakes and resulting tsunami to take actions that will save lives but society seems unwilling to take the necessary steps.
- Mega-quakes are difficult to predict so society is not prepared to try.
- The town of Seaside, Oregon, is not sufficiently prepared to do what's needed to minimize the effects of a large tsunami arriving at it's coast.
- Mega-quakes experienced in Japan have provided good examples of what Wester North America is likely to experience.
- We do not yet know enough about the earthquake history of the Cascadia region to commit to any specific mitigating strategies.
- Scientists of many types are working hard individually and collaboratively to understand both the history and likely future pattern of megathrust earthquakes in the Cascadia region.

Which of these claims were supported with arguments or discussions presented in this article? Choose either Yes or No for each question.

☐ Was the claim "*The stuck edge of North America is compressing eastward at the rate of thirty to forty millimeters a year*" supported by argument or discussion in the article?
Yes / No, the claim was just stated.

☐ Was the claim "*Rocks making up the edge of North American are young and still relatively elastic*" supported by argument or discussion in the article? Yes / No, the claim was just stated.

For each question, is the statement given in italics part of an argument that supports the corresponding claim (paraphrased from the article)?

☐ The statement "*In 2009, he found some land for sale outside the inundation zone, and proposed building a new K-12 campus there*" is part of an argument that supports the claim "*A mega-quake occurred in the Cascadia region in 1700."* **True / False**

☐ The statement "*FEMA calculates that 3000 schools will not survive a magnitude 9.0 earthquake in the Cascadia region*" is part of an argument that supports the claim "*The region is not well prepared for the effects of a mega-quake."* **True / False**

☐ The statement "*Samples of the sea floor were collected all along the Pacific West Coast to determine where and when underwater landslides occurred*" is part of an argument that supports the claim "*A mega-quake occurred in the Cascadia region in 1700."* **True / False**

☐ The statement "*Dendrochronology in 'ghost forest' trees revealed that the date of the last growth rings in all trees was 1699"* is part of an argument that supports the claim "*The region is not well prepared for the effects of a mega-quake."* **True / False**

Was each of these arguments supported by describing or citing data, methods, or people responsible for the information?

☐ Was the argument "*North America bulges upwards an average of 3mm to 4mm per year*" supported by describing or citing data, methods, or people responsible for the information?
Yes / No, data or methods were neither mentioned nor referenced.

☐ Was the argument "*We now know that the Pacific Northwest has experienced forty-one subduction-zone earthquakes in the past ten thousand years*" supported by describing or citing data, methods, or people responsible for the information?
Yes / No, data or methods were neither mentioned nor referenced.

☐ Was the argument "*FEMA calculates that two thirds of railways and airports will collapse or be compromised in the earthquake*" supported by describing or citing data, methods, or people responsible for the information?
Yes / No, data or methods were neither mentioned nor referenced.

What kind of data are each of the following? Choose an option to fill the blank.

☐ "*Average recurrence interval of Cascadia megathrust earthquakes*" is best described as ____ .

- a quantity or quantities that were measured with instruments of some sort
- information that was observed – i.e. seen or noticed, not measured with instruments
- data that was simulated, modelled or calculated
- information collected from people, archives, records etc.
- not really data at all

☐ "*The first sign that the Cascadia earthquake has begun will be a compressional wave*." The exact arrival time of that compressional wave is best described as ____ (same options).

☐ Historical written accounts of tsunami occurrences in Japanese harbours are best described as ____.