**Group 1: Use of new techniques (incl. simulation, machine learning, AI, and others) to model the behavior of civil infrastructure and risk to communities due to loading from natural hazards**

**Point-of-Contact:** Rakesh Salunke

**Regular Meeting Time: Every second Wednesday, 5:30 PM CST/6:30 PM EST.**

**Ti**meline:

* Feb 17, 2023 - Project Ideas and Titles due
* Feb 24th, 2023 - Abstracts due
* Mar 3rd, 2023 - Project Feedback
* Mar 10th, 2023 - Second check-in meeting
* April 14th, 2023 - Third check-in meeting
* May 12th, 2023 - Final check-in meeting
* May 26th, 2023 - Research Challenge Results Presented at the Mini-Conference

Preliminary Collaborative Research challenge abstracts are due by February 24, 2023, and can be submitted through the  [Abstract submission form](https://forms.gle/t4M6vqk2njCr3i1fA). All groups will present their research challenge findings on Friday, May 26, 2023, at the inaugural NHERI GSC Mini-conference.

**By Friday, February 17, submit the following:**

* What is the motivation for your project?
  + What are you trying to understand that we don't already? What is the gap that you're trying to fill?
* What are your research question(s)?
* What dataset(s) do you plan to use?
* What method(s) do you plan to use?
* Are there any special considerations for your project?
  + This could include Internal Review Board (IRB) application for a restricted-use dataset, experimental procedures, etc.
  + What is your plan if that falls through?
* How is your project interdisciplinary?

**TO DO:**

* Set up Whatsapp
* Study up on BRAILS
* Choose a project idea and create a project title (collaborate in Whatsapp)

NOTES:  
This tool seems to align well with our group’s expertise:

* <https://nheri-simcenter.github.io/BRAILS-Documentation/>
* BRAILS: AI tool that gathers structural data.
* Building Recognition using AI at a Large Scale
* Has an ensemble of different models that can be used on several applications. We can add more to it if we want.
* SoVI Index to what we do? Social aspect to losses and casualties. Look at how different communities may be helped differently based on social
* Finding social vulnerability wise in the

<https://hazards.fema.gov/nri/map>

**Idea:**

**Use of BRAILS (AI) to identify buildings vulnerable to collapse during an earthquake. Will compare vulnerability of residential structures to housing tenure type.**

**Use of BRAILS To Understand Potential Earthquake Damage in Relation to Community Assets**

**Submit Project Title here:** [**https://docs.google.com/forms/d/1dhw2JSA\_nWeE8QvP55W4-Eoa3Qs2Z8zjRFUbKPzNtmU/edit?pli=1**](https://docs.google.com/forms/d/1dhw2JSA_nWeE8QvP55W4-Eoa3Qs2Z8zjRFUbKPzNtmU/edit?pli=1)

**Assess Potential Earthquake Damage,Loss and Compare with Social Vulnerability Indicators**

Our assigned topic is the use of new techniques (incl. simulation, machine learning, AI, and others) to model the behavior of civil infrastructure and risk to communities due to loading from natural hazards. We want to understand the use of AI and simulation tools to better understand infrastructure damage and how surrounding communities may have to adapt should an earthquake occur. Recognition using AI at Large-Scale (BRAILS) is AI modeling program that can, using satellite imagery and Google street view, exact potential building damages from earthquakes. Our research question is: How can BRAILS in conjunction with EQ modeling tools be used to understand potential earthquake damage and social vulnerability in relation to community assets? Researchers plan to use BRAILS to develop regional inventory and use R2D or Hazus EQ model to understand potential earthquake damage in a specified area (location to be determined for example earthquake impacted regions in Turkey & Syria). The results of the analysis will be overlaid with demographic characteristics (race, income, home tenure type, and other details as appropriate, obtained via Hazus) to assess where potential building damages may impact socially vulnerable populations. The researchers will then overlay the locations of community assets (i.e. schools, houses of worship, community centers, etc.) as indicated via Google data and perform geospatial analysis to determine which assets may be resilient to earthquake shaking and also be near socially vulnerable areas. Community assets meeting both criteria may be considered strategic facilities for collaboration with emergency management officials and serve important response and support roles in the event of an earthquake in the surrounding community. There are no special considerations for our project at this time. Our project incorporates the perspectives of an engineer, computational data scientist, and social scientist. The study has the potential to contribute to several intellectual fields and has broader impacts for practitioner communities.

**Tools: Use of NHERI Simcenter tools BRAILS & R2D or Hazus (FEMA’s natural hazard risk assessment methodology)**

**Outline**

1. Select geographical area
2. Regional Inventory using BRAILS
3. Identify Specific Earthquake epicenter Or generic Faultline
4. Use the USGS Shakemap to calculate and play with possibilities in that scenario and come up with results
5. Integrate building attributes output from BRAILS into R2D.
6. Separate by building classes based on occupancy level
7. Use existing Fragility Curves from Hazus, R2D, or other sources; OR, modify the fragility curves based on the location, type of structure, building codes, construction method, etc.
8. Run the analysis on R2D and determine the probability of failure of buildings
9. Classify assets based on probability of collapse: None, slight, moderate, extensive, complete
10. Compare results with social vulnerability indicators
11. Look into and analyze population statistics…see the social vulnerability of specific regions and assess the damages there;
12. Correlation between damage and population density, income, time of the event etc.
13. Figure out SOVI for Turkey
14. Our Contribution:
15. Make sure the Hazus EQ and/or R2D Fragility curve subset would be appropriate for the location of interest (Hatay, Kahramanmaras, and Gaziantep, Turkey)
16. Assess structural performance and estimate the probability of failure of buildings for another region within Turkey along the same Faultline??
17. Comparison of SOVI Indicators and develop new correlations
18. Formula to calculate SOVI for the region of interest

**Variables Available (at Towns and Villages Level) via Turkey Census Data**

All info is based on 2010 Census.

* Household Size
* Property Status (Homeowner vs. Tenant)
* Number of Rooms in Residence
* East of Use of the Residence (Bathroom)
* Ease of Use of the Housing (Pipe Water)
* Ease of Use of the Residence (Kitchen)
* Ease of Use of the Residence (Toilet)
* Total Resident Population
* Labor
* Population Status Not in the Labor Force
* Status at Work (Employment Type)
* Gender
* Human Age Group
* Ten Age Group
* 0-14, 15-64, 65+
* Disabled Population
* Disability Type
* Literacy
* Education Status
* Marital Status
* Living Born and Living Children
* Female Population by Number of Live Born Children

Finally, filed a BRAILS bug today. After repeated long-run-then-crashes I opened the following bug with the BRAILS dev team:

<https://simcenter-messageboard.designsafe-ci.org/smf/index.php?topic=318.0>

While running InventoryGenerator.generate(attributes='all')  
with location='Gaziantep, TR'  
  
I get a FacadeParser.py:145, at minLineIdx = int(np.argmin(xp)/2), where apparently xp is an empty sequence, with the following complete error trace:<snip>  
Any chance you can test for xp prior to the argmin(); or at least catch the exception more gracefully?

Still unsuccessful with creating sparse asset data for the Gaziantep, TR. Ideally, we can create inventory for the top 3 cities: Hatay, xxx, and Gaziantep.

Filed another bug against BRAILS. This one is a little different. Seems like Google StreetView is not returning a requested building’s façade image. We suggest handling this exception by skipping the problem building rather than completely crashing…

<https://simcenter-messageboard.designsafe-ci.org/smf/index.php?topic=324.0>

Created a buildings.csv file of ~1.4m buildings in the affected 11 SE provinces (from the WB report) of Turkey. Zipped those in and checked into the github repository data\inv\ folder. The building footprints were simplified to centroids, but forcing for a centroid to be fully contained within the building.

Graphical user interface, diagram

Description automatically generated

Notice: the large L-shaped building true centroid (green dot in the lower right hand corner) is falling outside the structure, on top of a different structure. Used a method to enforce building centroid to always fall within the structrure (blue snowflake in the center). The buildings.csv zipped in buildings.zip is checked in the github repository under \data\inv\ folder.

Original source: <https://data.humdata.org/dataset/cod-ab-tur>

As we decided to use only the 11 affected provinces, I clipped the adm1 (provinces), and adm2 (districts) to the same shape of 11. Interestingly enough the adm3 that we got almost perfectly matches that shape, so no edits there. Here’s a composite thematic map:

Map

Description automatically generated

Original data: <https://data.humdata.org/dataset/hotosm_tur_buildings>

“In Türkiye, which is the focus of this report, these earthquakes have resulted in widespread damage across 11 provinces, where around 14.01 million (16.5 percent) of Türkiye’s population live, including **Adana, Adıyaman, Diyarbakır, Elazığ, Gaziantep, Hatay, Kahramanmaraş, Kilis, Malatya, Osmaniye and Şanlıurfa**. As of February 19, 2023, more than 41,020 fatalities have been reported, 108,068 people injured, and more than 1,200,000 people displaced.”

World Bank report: <https://documents1.worldbank.org/curated/en/099022723021250141/pdf/P1788430aeb62f08009b2302bd4074030fb.pdf>

Reviewing the dataset of destroyed buildings. Fairly small, 3-4k as of now, but potentially a lot bigger, hopefully, we can improve on this:

Map

Description automatically generated

Map

Description automatically generated

Original data: <https://data.humdata.org/dataset/hotosm_tur_destroyed_buildings>