TECHNICAL ADVISORY COMMITTEE
TO TEXNET AND BUREAU OF ECONOMIC GEOLOGY

Meeting Minutes
Tuesday, June 25, 2024 – 11:30 a.m. to 3:30 p.m.

OPENING

The meeting of the TexNet Technical Advisory Committee was called to order at ~11:30 a.m. on Tuesday June 25, 2024.

PRESENT

Alexandros Savvaidis, Manager of TexNet
Brian Stump, Committee Chair
Mark Boyd, Committee Member
Dave Cannon, Committee Member
Chris Hillman, Committee Member (via Zoom)
Jeff Nunn, Committee Member
Kris Nygaard, Committee Member (via Zoom)
Aaron Velasco, Committee Member
Scott Mitchell, Committee Member (via Zoom)
Larry French, Committee Member (via Zoom)
Mark Shuster, Interim Director, Bureau of Economic Geology
Elizaveta Rybina, TexNet Admin Program Coordinator
Jenna Watts, Office of Governmental Affairs and Initiatives, The University of Texas at Austin
Shawn Maxwell, CISR SAC (via Zoom, during the agenda item #5)
Mark Petersen, Supervisory Research Geophysicist with the Earthquakes Hazard Program, USGS (via Zoom)

AGENDA FOR JUNE 25th MEETING

1. Approval of Minutes of the March 26th, 2024, meeting.
2. Update on the Hiring Plan (15 min)
3. Lunch (45 min)
4. Network expansion needs for Midland Basin (15 min)
5. CISR SAC needs (Shawn Maxwell) (30 min)
6. Texas Earthquake Hazard Plan (60 min)
7. Operations and Research plan update (30 min)
8. Biennial report preparation (15 min)
9. Publications and presentations update (15 min)
10. TexNet TAC suggestions for the subsequent meetings (15 min)

APPROVAL OF DECEMBER 6TH, 2023 MEETING MINUTES

The Committee reviewed the March 26th, 2024, Meeting Minutes with no changes being suggested; as such a motion was made to approve the Meeting Minutes and the motion unanimously approved.

HIRING UPDATE

Alexandros Savvaidis introduced the recently updated TexNet Organogram to the TAC, which reflected hiring changes in Field Operations, Seismic Analysts, IT/CS, and Scientific Support:

- Xing Li, Postdoctoral Fellow, was hired on 05/20/2024.
- Camilo Munoz, Earthquake Analysis Systems Scientist, was hired 06/10/2024.

- Bernando Garcia (UTemp RSA) leaves TexNet in June 2024. TexNet plans to reopen this position.
- Jake Lee received tenure track position at UTPB and is planning to leave BEG in August 2024.
- TexNet is working on an offer letter for the Instrumentation Engineer and conducting interviews for the IT position.

LUNCH WITH THE NEW TEXNET HIRES

During the lunch, there was a general discussion between the TAC and the new hires (Xing Li and Camilo Munoz). The group described their job responsibilities and how they work together responding to TexNet needs.

UPDATE ON NETWORK EXPANSION NEEDS FOR MIDLAND BASIN

While network coverage in the Permian Basin has been satisfactory for the past two years, TexNet needs to expand the network in the Delaware Basin and Midland Basin by using either TexNet funding or industry funding.

Alexandros Savvaidis presented two maps - one using web catalog earthquakes and the other using detected earthquakes - and updated the TAC on TexNet's network expansion parameters:

1. Distribution of Industry operations (Injection)
2. Based on detected seismicity, epicentral distance of first and second station at 4 and 10 km, respectively
3. Minimize the azimuthal gap between an earthquake and seismic stations

Alexandros Savvaidis stressed that in-order-to be more proactive it is important for TexNet to have 4 km coverage between stations in the high priority area.

Mitchell County was suggested to be prioritized due to deep disposal, increased magnitudes, and growing seismicity.

CISR SAC NEEDS

Shawn Maxwell joined the meeting. He and TexNet TAC members introduced themselves. TexNet welcomed Shawn. CISR SAC has expressed interest in discussing some common interests with the TAC. Shawn Maxwell thanked TexNet TAC for the opportunity to have this conversation. Shawn Maxwell appreciated TexNet's work on seismicity assessment, highlighted its benefits for everyone, and discussed the following topics with TexNet:

1. Research sponsors that potentially may collaborate with TexNet as well as with CISR.
2. Importance of updating the earthquake hypocenter depth uncertainty information for Texas.
3. Ways CISR SAC can contribute and collaborate:

- Geophysical data gaps for the earth model for the Midland Basin to be shared with TexNet.
- Potential access to private arrays real-time data that are often subject to data licensing.
- Identification of key areas highlighting where new stations could be deployed from the industry and be shared with TexNet.

4. Hazard and risk assessment for the State of Texas and the magnitude completeness of the catalog as discussion topics during collaborative meetings in December 2024

TEXAS EARTHQUAKE HAZARD PLAN

Mark Petersen, Supervisory Research Geophysicist with the Earthquakes Hazard Program, USGS, thanked TexNet for the interest in the National Hazard Model and presented the Texas Hazard Plan. USGS developed the US National Seismic Hazard Model for 50 states, completed in December 2023.

- Mark Petersen provided an update and quick overview of the National Hazard Model, especially as it pertains to Texas.
- Shared maps showing where and how much the ground can shake from an earthquake. These maps are considered in the building codes in all states, used by insurance companies, risk modelers, and emergency management.
- Reviewed rupture forecast ground motion model that provides important information for policy-making decisions on public safety and resilience.
- Provided an overview of induced seismicity in Texas and other states, such as Oklahoma and Kansas. Though it is concerning and can cause hazard, USGS considers induced seismicity separately as one-year forecast as it can change rapidly by manmade activity. USGS previously created one-year forecasts to enhance public understanding of hazards, raise awareness, and inform industry of induced seismicity consequences. They no longer produce such maps.
- Compared ground motion amplification in the central and western US, including South Texas, emphasizing the need for regional ground motion models in risk assessment.
- Explored the potential for a five-year forecast for establishing certain standards based on previous events, both induced and natural seismicity, by their magnitude.

Alexandros Savvaidis proposed a two-year, adaptive to operations and time dependent hazard assessment plan, with an additional two-year projection if required. He discussed with TAC the following related topics:

- Seismic Risk Assessment components, such as risk and hazard, exposure, fragility, intensity, economic impact, and consequences
- Seismic hazard and risk projects already conducted (2015-2024)
- Ground motion attenuation curves for Texas used in estimating Local Magnitude ML (TexNet)
- Comparison of Nuisance to Fragility/Damage

For the next steps in assessing Texas earthquake hazard, Alexandros Savvaidis suggested collaborating with USGS to evaluate the following aspects for each area of interest:

1. Seismicity distribution and earthquake source information including known rupture zones.
2. Time dependent hazard, using crustal deformation studies, seismicity trends and industry operations data when available.
3. Estimates of wave path characteristics (anelastic attenuation and geometrical spreading) incorporating ground motion data and geophysical data (e.g., 3D seismic).
4. Improvement of Site amplification (Soil conditions) information with direct measurements and available data analysis.
5. Provide a Ground Motion Model for both near and far field for each area of interest including individual estimates of dominant period associated with the ground motion.

Alexandros Savvaidis invited Mark Petersen (USGS) to attend the next TexNet TAC meeting in person for further cooperation. Mark Petersen expressed interest in working collaboratively with TexNet as it would be beneficial for everyone.

OPERATIONS UPDATE

1. Four new stations deployed from TexNet in 2024-Q2:

- EF06 and EF08 (Eagle Ford); TexNet funded
- PB58 and PB59 (Delaware Basin); Operators funded

Three new stations are deployed from Operators and data provided to TexNet: HP02, VW01, and EE01.

Plan to deploy 2 new stations in Eagle Ford to fill the gap to the west of the current array.

2. Reporting Automatic Events for the M1.5 threshold

- As of November 1st, 2023, report auto-picked events of M1.5+ for the Delaware Basin. Manually review events at the next business day or as soon as possible thereafter.
- As of April 1st, 2024, report auto-picked events of M1.5+ for the Eagle Ford. Manually review events at the next business day or as soon as possible thereafter. TexNet is also reviewing the earth model for Eagle Ford and hopes to have an update soon.
- As soon as the Midland basin seismic network density increases to a similar level as the Delaware basin, report auto-picked events of M1.5+. TexNet will publish on our web site the map with station needs and share with stakeholder groups.

3. Seismicity pattern in 2024

- Most of the seismicity is in Northern Delaware Basin (seismicity rate; one M4+ in 2024-Q2)
- Seismicity increase in Eagle Ford (seismicity rate and highest magnitude; two M4 in 2024-Q1)
- Seismicity increase in the Midland Basin (Scurry-Fisher, Martin & Howard; one M4+ in 2024-Q2)

RESEARCH UPDATE

1. Alexandros Savvaidis updated TAC on Texas Vp & Vs Velocity Geomodel:

- Midland Basin 3D Vp model is available; working on Vs
- Testing Eagle Ford 1D Vp model
- Delaware Basin
    - Southern Basin 3D Vp model available
    - Working on Northern Basin 3D Vp model
    - Working on 3D Vs models

Alexandros Savvaidis also noted that network geometry is critical for it impacts the production of these models. The models will be published for public use upon completion.

2. Texas seismicity location uncertainty

TexNet plans to update location uncertainty information as soon as reference models are available.

This process will be repeated every few years depending on availability of new data (earth models, seismic stations).

Current plan:

1. Midland Basin (In progress using Midland 3D Vp 100m grid model as reference)
2. Delaware Basin (Pending reference model)
3. Eagle Ford

3. Additional Research Priorities

- Improve the geometry of the network identifying spots for new stations; Midland basin seismic station needs are available.
- Decrease the magnitude we report seismicity for the State. Homogenize the magnitude of completeness (Mc) for each basin.

- Update seismotectonic studies for the State by the end of 2024;
  Published work for Delaware and Midland Basins, and Eagle Ford. Pending publication for Snyder.
- Improve focal mechanism and moment availability using first motions, amplitude ratios (HASH) and full waveform moment tensor inversions (GISOLA). Pending publication.

4. Alexandros Savvaidis provided an update on Web Injection/Pressure Tool including cosmetic changes, additions, and newly required/optional fields.

RECENT & UPCOMING PUBLICATIONS AND PRESENTATIONS

Published Manuscripts

- Breton, C., Shensky, M., and Savvaidis, A., 2024. Induced seismicity data prep: Automate data processing and data set production in Texas and New Mexico using Python and ArcGIS Pro tools. Interpretation, https://doi.org/10.1190/int-2023-0013.1
- Chen, Y., Savvaidis, A., Saad, O.M., Huang, G.-C. D., and Siervo, D., 2024, TXED: Texas Earthquake Dataset for AI. Seismological Research Letters, https://doi.org/10.1785/0220230327
- Chen, Y., Zhou, M., and Abma, R., 2024. Revisiting two notable methods for improving the deblending performance of marine towed-streamer acquisition. Geophysics, 89, https://doi.org/10.1190/GEO2022-0621.1
- Dommisse, R., 2024. Constraining Faults and Stratigraphic Zones in Shale and Tight Oil Basins via 3D Geocellular Models. Geoenergy Science and Engineering, vol. 240, 212991, https://doi.org/10.1016/j.geoen.2024.212991
- Huang, G.-C. D., et al., 2024. Complex Seismotectonic Characteristics in the Midland Basin of Texas: Constrained by Seismicity and Earthquake Source Mechanisms. Seismological Research Letters, https://doi.org/10.1785/0220230269
- Saad, O.M., Helmy, I., Mohammed, M., Savvaidis, A., Chatterjee, A., and Chen, Y., 2024, Deep Learning Peak Ground Acceleration Prediction Using Single-Station Waveforms. IEEE Transactions on Geoscience and Remote Sensing, 62, 5907213, https://ieeexplore.ieee.org/document/10440360
- Huang, G-C. D., Chen, Y., and Savvaidis, A., 2024. Complex Seismotectonic Characteristics in the Midland Basin of Texas: Constrained by Seismicity and Earthquake Source Mechanisms. Seismological Research Letters, 95 (3): 1870–1884, https://doi.org/10.1785/0220230269
- Chen, Y., Savvaidis, A., et al., 2024, Deep Learning for P-Wave First-Motion Polarity Determination and Its Application in Focal Mechanism Inversion. IEEE Transactions on Geoscience and Remote Sensing, vol. 62, 10.1109/TGRS.2024.3407060
- Chen, Y., Savvaidis, A., Saad, O.M., Huang, G-C. D., et al., 2024. Thousands of Induced Earthquakes per Month in West Texas Detected Using EQCCT. Geosciences, 14, 114, https://doi.org/10.3390/geosciences14050114

Manuscripts under review

- Lee, J., Chen, Y., Dommisse, R., Huang, G. D., and Savvaidis, A., 2024. Basin-Scale Prediction of S-wave Sonic Logs Using Machine Learning Techniques from Conventional Logs. Geophysical Prospecting, (final revision).
- Saad, O.M., Savvaidis, A., and Chen, Y., 2024. Transfer Learning for Seismic Phase Picking in Texas. Seismological Research Letters, under review.
- Huang, G.-C. D. and Savvaidis, A., 2024. Reactivated Seismogenic Faults and Earthquake Source Mechanisms in the Snyder Area of Texas. Seismological Research Letters, under review.
- Skevofilax, C., 2024. Induced Seismicity by Oil and Gas Operations: Developing TexNet's Earthquake Injection Analysis Tool for Insightful Data Analysis of Inducement Trends, under review.
- Chen, Y., et al., 2024. Real-time earthquake monitoring in Texas using the highly precise deep learning phase picker, Earth and Space Science, under review.
- Parastatidis, E., et al., 2024. How effectively do different representations of fracturing capture observed seismic wave behavior? Numerical and Analytical Methods in Geomechanics, under review.

Presentations

- Chen, Y., et al., 2023. A Texas earthquake dataset for seismological artificial intelligence. December 15th, 2023, San Francisco, AGU Fall meeting, Poster.
- Chen, Y., et al., 2024. Deep learning for DAS denoising. March 09th, 2024, Houston, BP America.
- Chen, Y., et al., 2024. Benchmark dataset and framework accelerate research. March 12th , 2024, Houston, Saudi Aramco.
- Savvaidis, A., et al., 2024. Earthquake swarms of complex seismotectonic features in West Texas, USA. March 22nd, 2024, Vienna, EGU.
- Dommisse, R., 2024. Update on Permian Basin 3D Velocity Model. Apr. 27 - Apr. 30, 2024, Abilene, Texas, SWS AAPG Annual Meeting.
- DeShon, H., et al., 2024. Using Converted Phases to Investigate Induced Seismicity in the Midland Basin, Texas. May 1st, 2024, Anchorage, Alaska, SSA.
- Grigoratos, I., et al., 2024. Undocumented cases of induced seismicity in Oklahoma and Texas. May 1st, 2024, Anchorage, Alaska, SSA.
- Savvaidis, A. et al., 2024. Seismicity Triggering in the North Delaware basin, West Texas, USA. May 1st, 2024, Anchorage, Alaska, SSA.
- Zanjani A., DeShon H., and Savvaidis, A., 2024. Spatiotemporal Evolution of Induced Earthquakes in the Southern Delaware Basin, Reeves-Pecos, West Texas. May 1st, 2024, Anchorage, Alaska, SSA.
- Chen, Y., et al., 2024. An AI-Assisted Real-Time Earthquake Forecasting Case Study in China. May 2nd, 2024, Anchorage, Alaska, SSA.
- Pandel, B., Rathje, E. , Savvaidis, A., and Kottke, A., 2024. Stochastic Inversions of Source, Path, and Site Parameters for West Texas Earthquakes. May 2nd, 2024, Anchorage, Alaska, SSA.
- Chen, Y., et al., 2024. Real-Time Earthquake Forecasting in China Using AI. May 26th, 2024, Chiba, Japan, Geoscience Union.
- Chen, Y., et al., 2024. Machine learning for earthquake forecasting and early warning. May 28th, 2024, Chiba, Japan, 8th International Workshop on Earthquake Preparation Process, – Observation, Validation, Modeling, Forecasting.
- Chen, Y., et al., 2024. Tuning a passive-seismic phase picker using TXED. June 11th, Oslo, Norway, EAGE.
- Savvaidis, A. and Grigoratos, I., 2024. Causal assessment of anthropogenic seismicity in Texas and New Mexico. June 11th, Oslo, Norway, EAGE.
- Lee, J., Chen, Y., Dommisse, R., Savvaidis, A., 2024. Rock Physics Attribute Analysis for Identifying Brittle Zones in Upper Delaware Basin Formations. International Meeting for Applied Geoscience & Energy 2024. (Submitted)
- Lee, J., Dommisse, R., Savvaidis, A., 2024. Constructing a Comprehensive 3D S-Wave Velocity Model of the Delaware Basin. International Meeting for Applied Geoscience & Energy 2024. (Submitted)
- Parastatidis, E., Hildyard, M., Pytharouli, S., Savvaidis, A., 2024. Study of the effect of pre-existing fractures in the reservoir on the potential for induced seismicity for hydro storage dam projects. International Meeting for Applied Geoscience & Energy 2024. (Submitted)
- Parastatidis, E., and Savvaidis, A. 2024. Array design: how can we maximize the event detectability on Carbon Capture Storage and geothermal stimulation sites. European Seismological Commission 2024. (Submitted)

DISCUSSION OF TX SWP LETTER ADDRESSED TO TEXNET TAC

Alexandros Savvaidis briefed TAC members on the Texas Seismicity and Water Partnership (TXSWP) letter requesting TexNet update the hypocentral depth uncertainties associated with its current and historical event catalogs. TAC appreciated the letter and discussed the response to TXOGA-TXSWP.

SUGGESTED TOPICS FOR NEXT MEETING

Possible topics that were suggested for discussion at the next meeting were proposed as follows:

1. Update on hiring plan (5min)
2. Update on releasing M1.5+ auto-picked events (10min)
3. Budget split (e.g. equipment, maintenance, computer hardware, staff) (15min)
4. Lunch (30min)
5. TexNet operations and research activities (60min)
6. Earthquake Hazard Plan (60min)
7. Biennial Report (45min)
8. Publications and presentations update (5min)
9. Suggestions for the subsequent meetings (10min)

ADJOURNMENT

Meeting was adjourned at ~3:30 mm by Brian Stump, Committee Chair

Minutes prepared by: Elizaveta Rybina, TexNet

Minutes reviewed by: Alexandros Savvaidis, TexNet

Minutes approved on December 3rd, 2024, by:

Brian Stump, Committee Chair
Mark Boyd, Committee Member
Chris Hillman, Committee Member
Jeff Nunn, Committee Member
Aaron Velasco, Committee Member
Dave Cannon, Committee Member (via Zoom)