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WASHINGTON, March 14 -- The University of Texas at Austin ***Bureau of Economic Geology*** has issued a 58-page report dated Nov. 30, 2020, entitled: "2020 Biennial Report on Seismic Monitoring and Research in Texas".

The report was prepared by Alexandros Savvaidis, Peter Hennings, Ellen Rathje and Kimberly Rife.

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Executive Summary

The Texas Seismic Monitoring and Research Program (TexNet) at the ***Bureau of Economic Geology*** was created by the 84th Texas Legislature to address the increase of seismicity in Texas that began in 2009. TexNet was appropriated \$3.4 million for the current biennium by the 86th Legislature. With these funds TexNet expanded the network seismic stations, decreased the time for cataloging and reporting earthquakes, and conducted research to better understand seismicity in the state. The most significant accomplishments of TexNet during the current biennium:

* USGS approved TexNet as a self-supporting Advanced National Seismic System member based on extensive technical qualification review.

* TexNet continues to determine the causes of Texas earthquakes and help to limit the damage from any future Texas earthquakes.

* A healthy and safe Texas oil and gas industry is vital to the state's continued prosperity, and TexNet plays a key supporting role in enabling and building that prosperity. With companies, state agencies, and public and private

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state universities as partners, TexNet helps the oil and gas industry to operate safely within the state, ensuring continued production from Texas plays and the associated stream of state production-tax revenue.

* TexNet provides uninterrupted high-quality waveform data, continually cataloging earthquakes and improving their location accuracy, freely available to all. A timely, updated earthquake catalog is available at <https://www.beg.utexas.edu/texnet/catalog>, providing near-real-time earthquake information to all Texans.

* TexNet distributes earthquake information 24/7 in less than 20 minutes from the time of occurrence for all events with magnitude greater than or equal to 3.0.

* TexNet's field crews successfully continue to provide seismic station maintenance while following strict COVID-19 safety protocols.

* TexNet is documenting and assessing ongoing seismic activity in seven main areas (see Figure 5.1): the Delaware Basin and the Midland-Odessa area of West Texas; the Panhandle; the Dallas-Fort Worth area; East Texas; the Eagle Ford area; and Cogdell field near Snyder. All these areas have experienced at least one felt earthquake event with magnitude higher than 3.0 since September of 2019.

* During 2019, the highest-magnitude event (ML 4.2) occurred on September 30, near Snyder (in the Midland Basin). In 2020 (through October), the highest magnitude event (M4.9) occurred in the Delaware Basin along the Culberson-Reeves County line. From March to July 2020 (the onset of COVID and oil price decline), seismicity dropped except in the Permian Basin. Seismicity began to increase in August 2020 in the Eagle Ford, Permian, and Snyder areas, illustrating the critical importance of real-time monitoring across the state.

* Based on TexNet research results and peer-reviewed publications, we conclude that recent seismicity in the Delaware Basin is most likely induced by a combination of hydraulic fracturing and saltwater disposal.

* Although the seismic risk in the Dallas-Fort Worth urban area decreased during the current biennium (consistent with a decrease in measured seismicity), seismic risk increased in the Midland-Odessa region, where 13 events with magnitude greater than or equal to 3.0 have occurred (compared with none in the previous biennium).

* Consistent with its mission to serve the State of Texas, TexNet leadership meets regularly with the TexNet TAC and the Railroad Commission to discuss the direction of data collection and future research outcomes, both important for regulatory decision-making. Leadership regularly meets with various stakeholder groups, including city councils, citizens' groups, and oil and gas operators.

* TexNet monitoring program was reviewed by an external peer-review panel in 2019. The panel included members from academia and industry. The peer-review team overwhelmingly endorsed the work that has been achieved in a short period of time. Also, the TexNet-CISR Annual Research Review was a success, with up to 120 attendees throughout the day. During the review, TexNet-CISR research teams presented the groundwork, studies, and findings evaluating seismic activity and how it has affected the State of Texas.

Recommendations: TexNet produces freely available data sets and associated analysis products that quantify in near-real-time seismicity in Texas. Both the data and data products are used by many to advance the overall understanding of Texas earthquakes. These products are critical to the assessment of earthquake hazards in Texas and support the mitigation of earthquake activity linked to human activity while assessing hazards and risks from future Texas earthquakes.

These critical, legislatively mandated tasks allow the State of Texas to remain prepared for earthquakes while ensuring the safety of the contributions of the oil and gas industry to its prosperity. This effective use of past resources invested in TexNet and its support of both the citizens of Texas and the oil and gas industry motivates ongoing TexNet funding as a stand-alone item in the state budget. In order to provide critical support for the citizens of Texas as well as maintain a robust oil and gas industry, and to extend understanding of earthquake risk by expanding the network and its vital capabilities, a budget of \$3.4 million for the FY 2022-23 legislative cycle is

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proposed. This proposed state investment is based on ongoing activities as well as external and independent assessments by state agencies, the oil and gas industry, and citizens.

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Impact of TexNet Research

During the current biennium (2020-21), following the recommendations of the TexNet TAC, we pursued research and delivered products that have significantly improved our understanding of induced (and natural?) earthquakes in Texas. Appendix A, which provides a list and brief description of the publications stemming from our work, demonstrates the breadth and depth of our progress.

Several of our projects and related publications document how TexNet is improving our ability to detect, locate, and analyze earthquakes statewide. We have honed existing techniques to catalog earthquakes promptly, and we are meeting performance metrics established by the independent TAC. We have developed and deployed new techniques to further improve location accuracy and to provide information promptly. Our work on earthquake location is on the leading edge of the science and has a high impact for our stakeholders (notably the petroleum industry and its regulators), supporting their investment and regulatory decisions that rely on accurate spatiotemporal seismicity trends.

Another category of significant advancement has been the characterization and explanation of the seismicity in different parts of the state, including highly populated areas (such as the Dallas-Fort Worth metropolitan area) and sites of increased oil and gas operations (including the Permian Basin and Eagle Ford play). Through this research, we have identified patterns and rates of seismicity, active faults (many previously unknown), and characteristics of ground motion. These research products are being used to evaluate the combination of natural factors and human influences that cause seismicity, to assess the changing seismic hazard, and to provide information to the State of Texas officials and local stakeholders who can help mitigate the associated risk. We mapped previously unknown fault zones, more fully characterizing known earthquake zones while developing a fault database that includes the susceptibility of each fault to rupture.

In areas with varying petroleum industry operations, we have created quality-controlled databases that document oil and gas operations data (e.g., hydraulic fracturing and wastewater injection). These data are being analyzed to identify the likely, and highly complex, association that these processes (hydraulic fracturing and wastewater injection) have with seismicity. By applying statistical or physics-based models, we developed new methods that identify isolated cases where seismicity is humanly induced and can hindcast earthquake hazard due to prior industry activity. In addition, we have combined geological and wastewater-injection information to provide comprehensive models that show how subsurface pore pressure has changed and thus altered the hazard due to injection.

Finally, our work on ground-motion models for earthquakes in Texas and neighboring states provides a framework to better assess the regional seismic risk and validates new ShakeMap models that are routinely used by emergency management authorities (such as the Texas Department of Emergency Management).

The developed ground-motion models, complemented by assessments of the fragility of critical infrastructure components (such as bridges), has improved the evaluation of seismic risk across the state. In allocating a portion of TexNet funding to vetted and high-quality peer-reviewed research, we are providing more accurate data and analyses about the evolving earthquake hazard in Texas.

Our work is being used daily by those in the petroleum industry and its regulators to protect the well-being of the citizens, and the socioeconomic vitality, of Texas.

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The full report can be viewed at:
<https://www.beg.utexas.edu/files/texnet/docs/2020%20Biennial%20Report%20on%20Seismic%20Monitoring%20and%20Research%20in%20Texas.pdf>

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