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Cursory Floodplain Dataset Technical Summary

With rapid changes in technology, the ability to estimate and depict flood hazard information has increased rapidly over the past few years and continues to change. One of such changes is that multiple flood hazard datasets have become available from various sources and FEMA's national flood hazard layer is no longer the single, most authoritative source of flood hazard data. The Texas Water Development Board (TWDB) is leading the development of several additional "advisory" (non-regulatory) datasets including Base Level Engineering (BLE), Cursory Floodplain Data, and the Floodplain quilt. The cursory flood hazards dataset is employed by TWDB as a gap-filling "rapid assessment" dataset for areas where flood hazard data is unavailable from the existing sources that make up the statewide compilation called the "Floodplain quilt." This cursory flood hazard dataset also provides a single, consistent, statewide dataset that can be efficiently updated and used for other research or planning purposes that require a dataset using a single, consistent methodology, rather than a compilation dataset of various analysis methods like the floodplain quilt. Researchers from the University of Texas at Arlington and the University of Texas at Austin reviewed the theoretical components of the Fathom modeling framework for its proper usages and limitations. This report summarizes the findings from the following perspectives:

1. Terrain (DEM) Data and Levee/Dam Profiles: The Fathom-Texas model computes flooding using a 100-ft scale digital elevation model (DEM), which is a relatively coarse resolution for simulating flood inundation. To provide more fine-grained output, the model results are downscaled to a DEM at a 10-ft resolution, which provides better mapping of flooded areas. The processes for both upscaling the existing fine-resolution DEM to the 100-ft scale for flood modeling and downscaling the model results to 10-ft scale for inundation analysis may affect the accuracy of the simulated flood area. In particular, the coarse-grid model cannot directly represent many dams and levees for general modeling. To address this limitation, Fathom includes two forms of results: (I) modeling of design storms where levees/dams are assumed to hold their designed flood levels so the areas they are designed to protect cannot be flooded, and (II) overtopping storms where the levees/dams are assumed to completely fail all along their length. Overall, the terrain and levee/dam approach taken in the Fathom-Texas data product provides reasonable estimates of likely flood inundation for TWDB's purposes in prioritizing future efforts. However, the Fathom data is not advised to be used for assessing the adequacy of individual dams/levees or potential under-design infrastructure relative to the increasing storms that Texas has experienced.

2. <u>Channel and Floodplain Characterization</u>: The accuracy of any flood model, to a certain extent, may be impacted by the ability to represent river channel and near-river floodplain geometry, especially for high-flow conditions. Unfortunately, adequate river surveys are not available throughout all of Texas to support rapid assessments at large scales such as the entire state. The Fathom-Texas model uses a simplified geometry to represent channel beds that are estimated using known, non-flooding river flows. This method is somewhat better than other conventional approaches such as the Manning's equation for open channels, which is demonstrated in a study published by the Fathom team (Neal, et al., 2021). The use of estimated geometry is one of the main differences between the Fathom-Texas and conventional detailed models. The important limitation of this method is that physical features in the river, such as dam outlets and waterfalls, which affect some flooding conditions, are not represented; thus, the geometry estimation introduces an uncertainty in the flooding results that cannot be directly quantified.
3. <u>Hydrology</u>: The Fathom-Texas hydrologic model for any flooding region is driven by two types of input data, or "boundary conditions", based on the size of drainage area (DA): (I) rainfall for selected design storms, e.g., the 1% chance or "100-year" storm, for DA less than or equal to 50 km^2, for estimating pluvial flood risk, and (II) upstream river inflows that are estimated using the well-known Regionalized Flood Frequency Analysis (RFFA), for DA above 50 km^2, to estimate fluvial flood risk. The frequency precipitation information from NOAA Atlas 14 (Perica et al., 2018) is directly utilized in the pluvial rain-on-grid model; the detailed, localized discharge estimates determined by the RFFA are applied to the fluvial model. While the RFFA is an accepted technique in hydrology to overcome our inability to monitor every river reach, it introduces a potential source of uncertainty in the Fathom-Texas data product because the accuracy of RFFA output depends on a sufficient distribution of gauges around the ungaged rivers. Many areas in Texas, particularly West and Northwest regions, are so sparsely monitored that the underlying assumptions of the RFFA can become questionable. This problem appears to be fundamental to the Fathom-Texas approach where limited data is available. An alternative modeling approach, such as rainfall-runoff modeling, that does not require the RFFA would be computationally expensive and perhaps impractical for the large sparsely gauged regions in Texas.
4. <u>Hydraulics</u>: The Fathom-Texas hydraulic model is based on the LISFLOOD-FP model, which has two decades of efforts invested in research, development, and applications. The model has been extensively validated and its limitations are understood. For the Fathom-Texas model, the key limitation is that flow down steep slopes (known as supercritical flow) cannot be accurately represented, leading to two likely consequences: (I) overestimation of flood inundation for steep (e.g., hill country areas) where flash flooding occurs, and (II) possible underestimation of flood areas downstream of steep slopes due to excess water retained in the upstream area. These biases must be considered by anyone evaluating flood inundation data from Fathom-Texas, for example areas in and around the hill country areas.

In summary, the Fathom-Texas dataset provides adequately detailed flood inundation information, however, users should be aware of the following limitations and use it with caution: (1) flood inundation information was generated from the model with limited infrastructure representations and operational data and tends to be underestimated for areas downstream of dams; (2) flood inundation for areas downstream of dams and/or protected by levees and areas surrounding reservoirs, lakes, and major river channels is subject to uncertainty; (3) flood inundation for areas with rapidly changing water flow may exhibit overestimated water depths; and (4) regions with fewer stream gauges like West Texas and Northwest Texas are subject to uncertainties in flood inundation.