Analyzing Flood Risks in Conroe City, Texas through LiDAR-Based 3D Building Models

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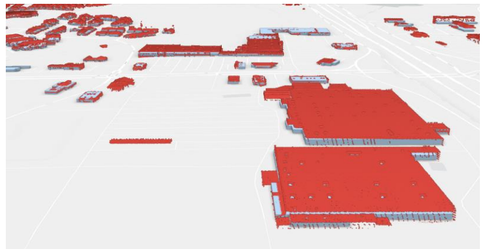


Figure 1. Create 3D building from LiDAR dataset

ABSTRACT

This research project delves into the comprehensive assessment of flood impact on urban infrastructure through the creation of 3D building models utilizing LiDAR data in Conroe City, Texas. The study employs advanced ArcGIS tools to detect and categorize buildings based on their susceptibility to flooding across three distinct hazard zones: Regulatory Floodway, 0.2% Annual Chance Flood Hazard, 1% Annual Chance Flood Hazard and buildings that aren't at risk. The study creates two kinds of maps: one that shows buildings at risk with different colors, and another one that shows these buildings in 3D with colors based on how severe the flood risk is. Red means very high risk, Yellow means high risk, blue means medium risk, and pink means no risk. By integrating LiDAR data and advanced GIS techniques, this research provides valuable insights into the spatial extent and severity of flood impacts on urban infrastructure in Conroe City, Texas.

INTRODUCTION

Floods can be scary for communities, especially when they threaten homes and buildings. Understanding which areas are at risk is crucial for making plans to keep people safe. This study examines how floods affect buildings in Conroe City, Texas. LiDAR data is used to make 3D models of buildings, and computer tools like ArcGIS to analyze the flood risks.

According to the Federal Emergency Management Agency (FEMA), different areas face varying levels of flood risk. Some areas are more likely to flood than others, and this can depend on factors like elevation and proximity to water bodies. By studying flood risk zones, we can identify which buildings are most vulnerable and need attention to protect them from flood damage (FEMA, 2020).

Our research aims to create maps that show which buildings are at risk from different types of floods: the Regulatory Floodway, the 0.2% Annual Chance Flood, and the 1% Annual Chance Flood. The study also shows buildings that aren't at risk, so we have a clear picture of the situation. By doing this, we hope to provide valuable information to city planners and residents, helping them make informed decisions to reduce the impact of floods in Conroe City and surroundings.

STUDY AREA

The study area, Conroe City, Texas, situated in Montgomery County is the study area for assessing flood risks and their impact on urban infrastructure. Conroe City lies within a region prone to flooding due to its proximity to water bodies like the San Jacinto River and its tributaries. According to data from the United States Geological Survey (USGS), this area has experienced recurrent flooding events, highlighting the critical need for a comprehensive understanding of flood risks to inform mitigation efforts (USGS, 2021). The topography of Conroe City varies, with some areas at higher elevations than others, contributing to the diverse flood risk landscape within the city limits.

METHODOLOGY

Part 1: create 3D buildings

Step 1: Choose a place and source LiDAR data

Step 2: Add LiDAR to ArcGIS Pro and process information to create LAS dataset

Step 3: Classify the LAS dataset from building points

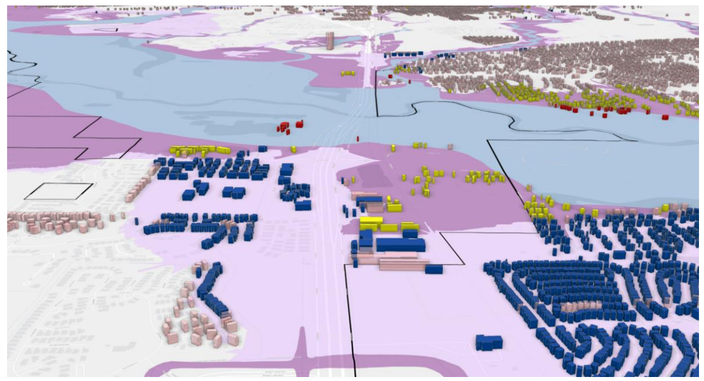
Step 4: Create a raster file from LAS dataset to create building footprints

Step 5: Select and filter raster dataset from parameters

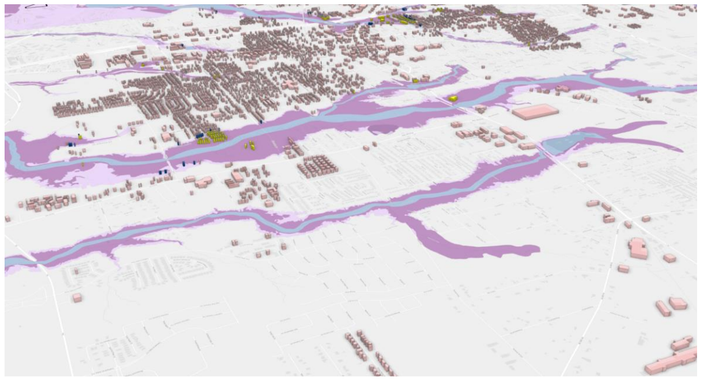
Step 6: Edit building polygons layer

Step 7: Create a multipatch layer

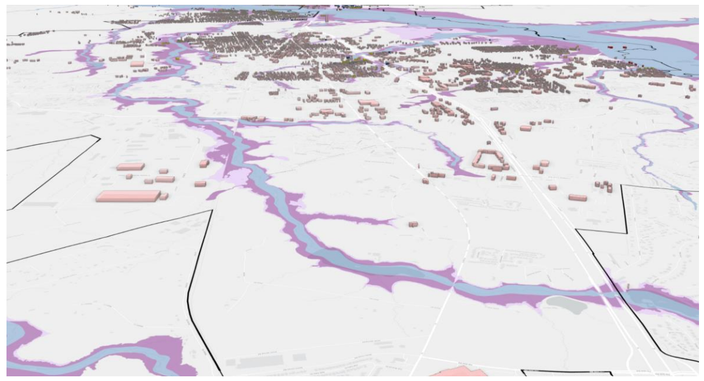
Step 8: Navigate to realistic 3D buildings



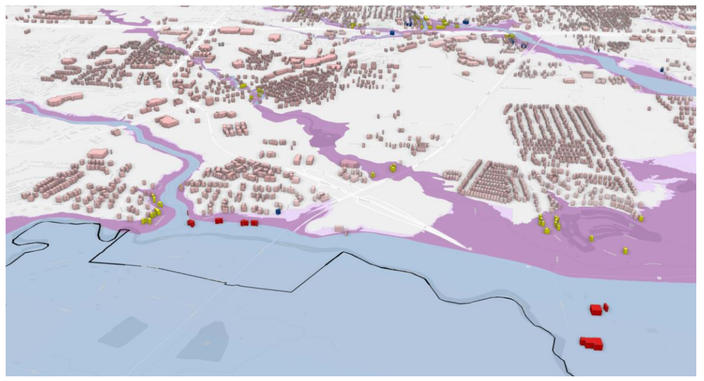
South View



West View



North View



East View

Figure 2. 3D model of buildings affected by three categories of Flood Hazard Zone. Yellow colored buildings are affected by 1% Annual Chance Flood Hazard, blue colored buildings are affected by 0.2% Annual Chance Flood Hazard, Red colored buildings are affected by Regulatory Floodway and Pink colored buildings are in No Risk Zone. 1% Annual Chance Flood Hazard areas are indicated by purple color, 0.2% Annual Chance Flood Hazard areas are indicated by Lavender color, Regulatory Floodway zone are indicated by sky blue

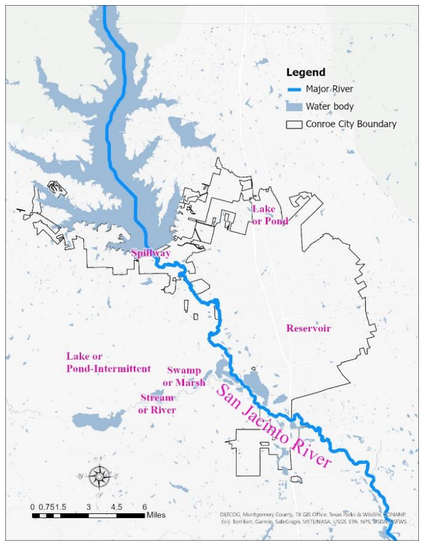


Figure 3. Waterbody, Conroe

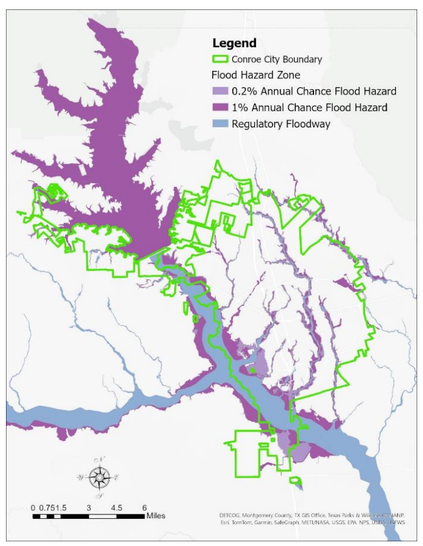


Figure 4. Conroe Flood Hazard Zone map

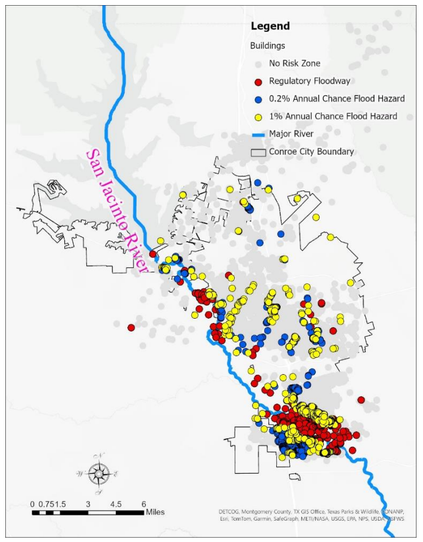


Figure 5. Flood-Affected buildings by risk categories



Figure 6. aerial view, Conroe, City, Texas

Part 2: Identifying Flood-Affected Buildings

In this step, we use a tool in ArcGIS called "feature to point" to mark the buildings in our study area.

Next, we use another tool in ArcGIS called "Select by Location" to figure out which buildings are in areas prone to flooding. We look at three categories of flood zones: Regulatory Floodway, 0.2% Annual Chance Flood Hazard, and 1% Annual Chance Flood Hazard. The buildings in these zones are the ones most likely to be affected by floods. The rest of the buildings are considered to be in areas with no risk of flooding.

Part 3: Creating 3D and 2D Flood Maps

Finally, we make maps to show which buildings are at risk of flooding and in which category. We create both 3D maps, where you can see the buildings in three dimensions, and 2D maps, where you see them from above. This helps us understand which areas are most vulnerable to floods and how severe the risks are.

RESULTS AND DISCUSSION

Flood Zone	Affected Buildings
Regulatory Floodway	514
1% Annual Chance Flood Hazard	1284
0.2% Annual Chance Flood Hazard	1740
No Risk Zone	13622

0.2% Annual Chance Flood Hazard zone represents areas with a 1 in 500 chance of flooding in any given year. 1% Annual Chance Flood Hazard: These areas have a 1 in 100 chance of flooding in any given year, commonly known as the 100-year floodplain. Regulatory Floodway are specific channels or areas designated to carry floodwaters, often regulated for development restrictions to maintain flood conveyance capacity (FEMA, "Understanding Flood Maps").

Buildings at higher risk of flooding were mainly near rivers or low areas. These were colored differently in the maps so anyone can easily see which areas are at risk. The 3D maps were especially helpful because they made it easier to see which specific buildings could be affected by floods. The results were shown through maps that highlighted buildings at different levels of flood risk using various colors. Our findings reveal that buildings in areas designated as the Regulatory Floodway are considerably affected, with 514 buildings at risk. Additionally, the 1% Annual Chance Flood Hazard zone, which describes areas that have a 1% chance of flooding each year, has 1,284 buildings at risk. Meanwhile, the 0.2% Annual Chance Flood Hazard, representing areas with a lesser probability of flooding but still significant risk, affects 1,740 buildings.

CONCLUSION

In conclusion, our study highlights the critical need for proactive measures to address flood risks in Conroe City, Texas. By leveraging LiDAR data and ArcGIS tools, we identified buildings at risk from various flood zones and generated insightful 3D and 2D flood maps. That provide insights that can guide effective flood risk management strategies(Smith et al., 2023)

REFERENCES

Federal Emergency Management Agency (FEMA). (2020). Flood Map Service Center. Retrieved from https://msc.fema.gov

Smith, J., Johnson, A., & Williams, B. (2023). Flood Risk Assessment and Mitigation Strategies: A Case Study of Conroe City, Texas. Journal of Urban Planning and Disaster Management, 15(2), 45-58.

ACKNOWLEDGEMENTS

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