Rising Waters, Rising Concerns: Levee Residual Risk in the Susquehanna River Basin

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Introduction

- Levees in the Susquehanna River Basin (SRB) have played a significant role in preventing flood-related damages. However, over 65% of the levees are nonaccredited, suggesting they may not be able to protect against the 100-year design flood. Levee failure maybe catastrophic, resulting in loss of life and high economic costs.

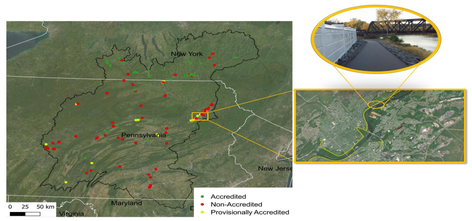


Figure1. Accreditation status of levees in the Susquehanna River Basin. The inset shows the Kingston to Exeter levees.

- Levee conditions are worsened by climate change, with a 71% increase in extreme precipitation in the Northeast region of the SRB.
- This study assesses levee residual risk for a section of the Wyoming Valley levee system in Luzerne County, Pennsylvania. Residual risk is the risk that remains after implementing a levee due to the levee's probability of failure.
- The section of the levee system examined extends from Kingston to Exeter, protecting 30,000 people and over 10,000 buildings valued at over $5 billion[1].

Scan for Acknowledgements and Citations

Methods

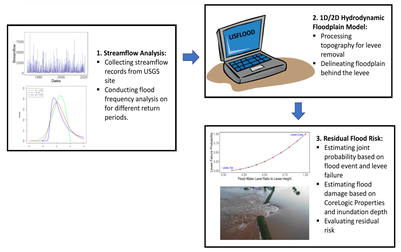


Figure 2. Illustration of methodology followed to estimate flood inundation and levee residual risk.

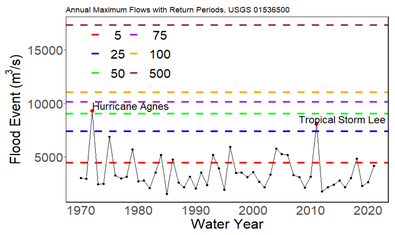


Figure 3. Frequency of various flood events at the USGS gauge for the study site.

- Pooled USGS streamflow gauge data at station 01536500 (1997-2020)
- Processed topography to remove levee footprints by eliminating elevations at levee locations and refilling using inverse distance linear interpolation.
- Joint probability of levee failure calculated by comparing flood water and levee crest elevations.
- Computed residual risk for each return period and reported expected annual residual risk.

Results

- Levee failure exacerbates inundation into the floodplain to varying degrees depending on the flood event severity or return period.
- Residual risk is significant for flood events larger than the 100-year flood.
- The expected annual residual risk from levee failure is estimated at over $0.5 million.

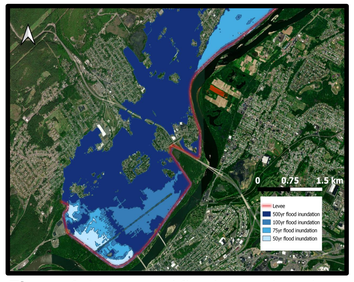


Figure 4. Incremental flood extent based on the flood severity or return period.

- Over 8,000 buildings affected by a 500-year flood.



Figure 5. Properties flooded by a 500-Year flood event.

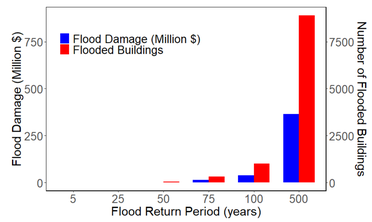


Figure 6. Flood damages across return periods in the absence of levees.

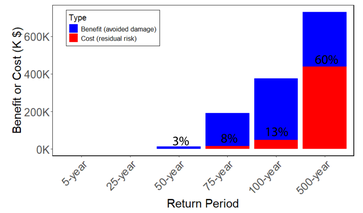


Figure 7. Benefit (avoided damages) and cost (residual risk) of levees across return periods.

Discussion

- The expected annual cost associated with the levee residual risk is ~40% of the expected annual benefit (calculated as the avoided damage from levees), indicating that residual risk is an important cost factor in the SRB.
- Although we only estimated levee residual risk for one community, our approach is scalable and transferable because it relies on national-level datasets (CoreLogic and National Levee Database).
- Floodplain managers must thoroughly assess and map the residual risks of levees in order to effectively mitigate the consequences of flooding events.