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Ph.D. DISSERTATION DEFENSE

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Title: CLIMATE IMPACTS AND ADAPTATION ASSESSMENT FOR FLUVIAL, COASTAL AND COMPOUND FLOODING

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ABSTRACT

Traditional analyses of flooding and its mitigation often study coastal and fluvial flood drivers in isolation, not enabling understanding of compound flooding, nor the accumulation of climate change influences (CCIs) on these drivers. CCIs include sea level rise (SLR), rain intensification and changes to storm surge. This dissertation demonstrates a holistic assessment of climate change induced flooding and adaptation for Eastwick, Philadelphia, which was recently affected by multiple severe fluvial floods. Multiple research tools including extreme value analysis of historical data, application of climate change projections and hydraulic modelling of both baseline and proposed adaptation scenarios are applied. Our results show that the SLR, usually overlooked in fluvial floodplains, has the potential to cause high tide flooding in Eastwick by the 2060s. SLR can further exacerbate flooding by introducing new overtopping areas thus indicating the need of flood models with appropriate setup to capture possible pathways in a fluvial-tidal floodplain. The analysis of mid and late-century CCIs on extreme fluvial, coastal and compound flooding events demonstrates that the present-day gap in flooding among these distinct events declines as the floodplain becomes increasingly filled by SLR later in the century. Our results also demonstrate that flood hazard is underestimated by traditional flood hazard assessment approaches only considering fluvial or coastal CCIs in isolation. Assessment of two proposed fluvial flood mitigation measures, a resistance approach based on a levee and an accommodation approach based on managed retreat, illustrates strengths and challenges of flood mitigation for a compound flood environment. Both approaches are effective at reducing fluvial and compound extreme events but not an extreme future coastal event. This dissertation reveals a simplified climate-informed flood hazard and adaptation assessment framework that can guide future flood management strategies, ensuring they are effective under evolving climate conditions and better protect vulnerable communities like Eastwick.