

Modeling residual flood risk behind levees, Upper Mississippi River, USA

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Abstract

Flood protection from levees is a mixed blessing, excluding water from the floodplain but creating higher flood levels ("surcharges") and promoting "residual risk" of flood damages. This study completed 2D hydrodynamic modeling and flood-damage analyses for the 459 km² Sny Island levee system on the Upper Mississippi River. These levees provide large economic benefits, at least \$51.1 million per year in prevented damages, the large majority provided to the agricultural sector and a small subset of low-elevation properties. However these benefits simultaneously translate into a large residual risk of flood damage should levees fail or be overtopped; this risk is not recognized either locally in the study area nor in national policy. In addition, the study levees caused surcharges averaging 1.2-1.5 m and locally as high as 2.4 m, consistent with other sites and studies. The combined hydraulic and economic modeling here documented that levee-related surcharge + the residual risk of levee overtopping or failure can lead to negative benefits, meaning added long-term flood risk. Up to 31% of residential structures in the study area, 8% of agricultural structures, and 22% of commercial structures received negative benefits, totaling \$562,500 per year. Although counterintuitive, structures at the margin of a leveed floodplain can incur negative benefits due to greater flood levels resulting from levees purportedly built to protect them. National levee policies and plans for local projects are unbalanced, crediting levee benefits but rarely fully planning for adverse impacts or considering alternatives.

Keywords: Flooding, floodplain management, social vulnerability, hydraulic modeling, Mississippi River

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