Reduction in storm surge from Hurricanes Isaac and Katrina through reforestation of the Maurepas Land Bridge

Michael Hopkins, Ph.D. & John Lopez, Ph.D.

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The Maurepas land bridge(isthmus) is a narrow strip of land that separates Lakes Maurepas and Pontchartrain. This land bridge is an integral part of the Louisiana coast because it acts as a storm surge buffer. For this reason, the Corps of Engineers described the land bridge as a "critical landscape feature" (USACE, 2009). As such, the Lake Pontchartrain Basin Foundation (LPBF) counts the Maurepas land bridge as one of 10 Pontchartrain Coastal Lines of Defense. The land bridge, however, is threatened. Prior to human settlement, the land bridge was covered by the expansive Manchac swamp. Significant portions of the Manchac swamp are degraded and have transitioned to marsh, which offers fewer benefits to storm surge reduction than swamp (**Fig. 1**).

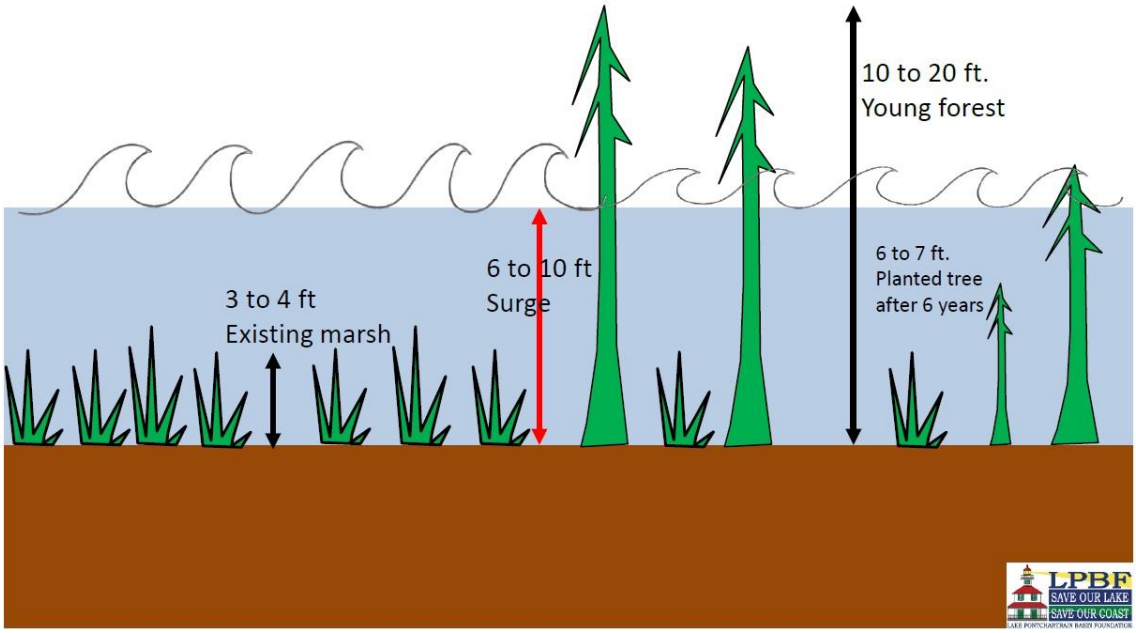


Fig. 1: Schematic diagram of storm surge and wave action on a marsh versus swamp. The diagram is meant to illustrate the greater dampening effect forest trees have on surge as opposed to marsh.

Large tracts of the Manchac swamp have been decimated and has largely been reduced to small degraded pockets near the edges of the land bridge. This destruction is the result of extensive logging in the late 1800s and early 1900s. Subsequently, saltwater intrusion from the Mississippi-River Gulf Outlet (MRGO) from the 1960s through the 2000s prevented natural regeneration. Since the closure of the MRGO in 2009, salinity has declined around the land bridge, which have resulted in conditions that are more favorable for swamps (Henkel, 2017). Swamps provide a better buffer to storm surge than marsh due, primarily, to the vegetation

type. Swamps are forests, whereas marshes are grass and shrubs. Simply put, trees create more friction to incoming storm surge than marsh and can attenuate waves more effectively. Additionally, restoring these areas as swamps can maintain the integrity of the land bridge itself by reducing its vulnerability to subsidence and erosion.

In 2019, LPBF contracted modeling work from the University of New Orleans and Moffatt & Nicol to gain a better understanding of storm surge dynamics within the Pontchartrain-Maurepas Basins. Part of that work consisted of examining the effects of a reforested Manchac swamp on the storm surge of Hurricanes Isaac and Katrina. **Figures 2** and **3** show maximum water level during each hurricane with the landscape as it exists presently (**Fig 2a** & **3a**) and the change in that maximum water level with a reforested land bridge (**Figs. 2b** & **3b**).

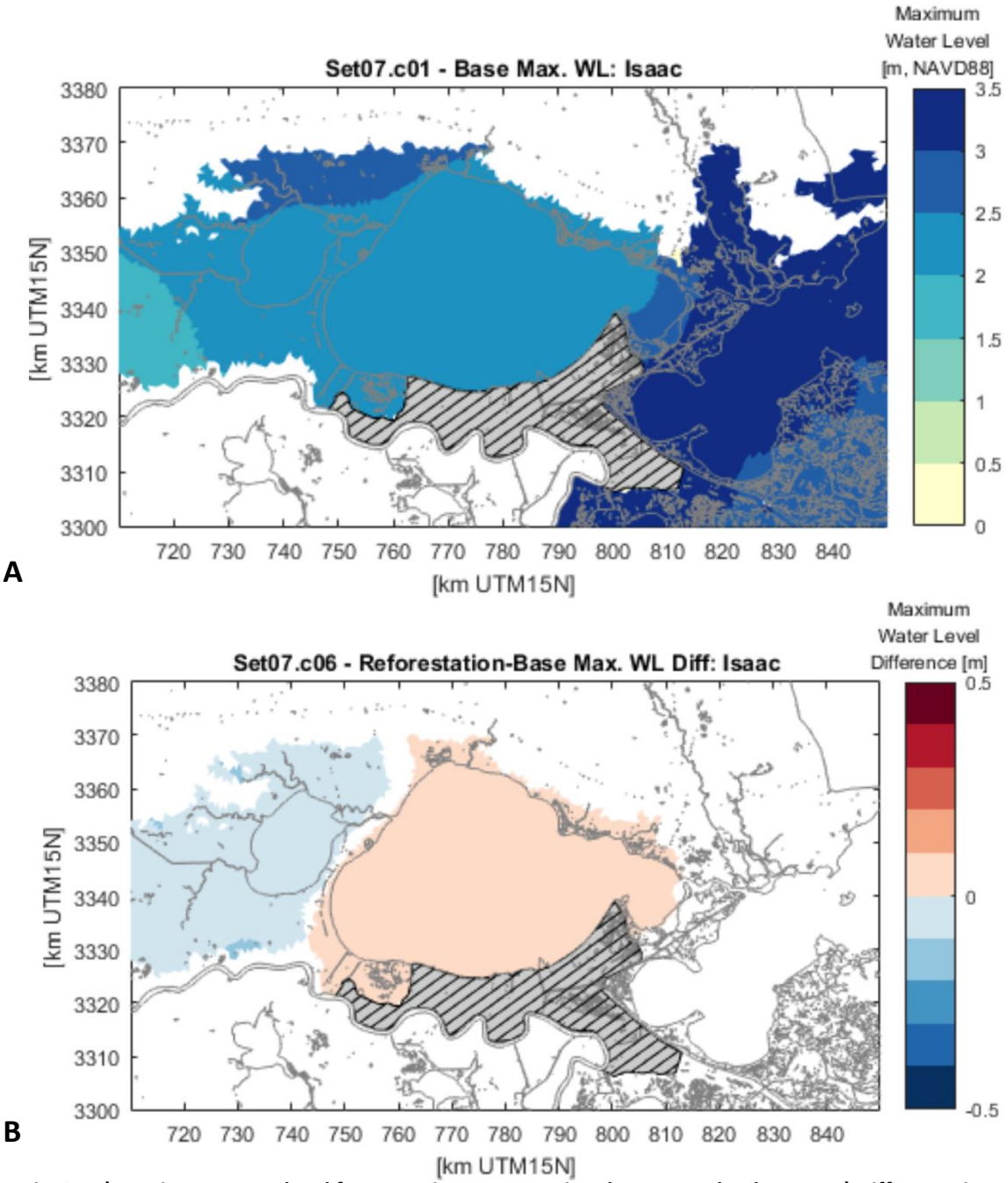


Fig. 2: A) Maximum water level from Hurricane Isaac using the present landscape. B) Difference in water level between the base case (water level in A) and the maximum water level with a reforested Maurepas land bridge.

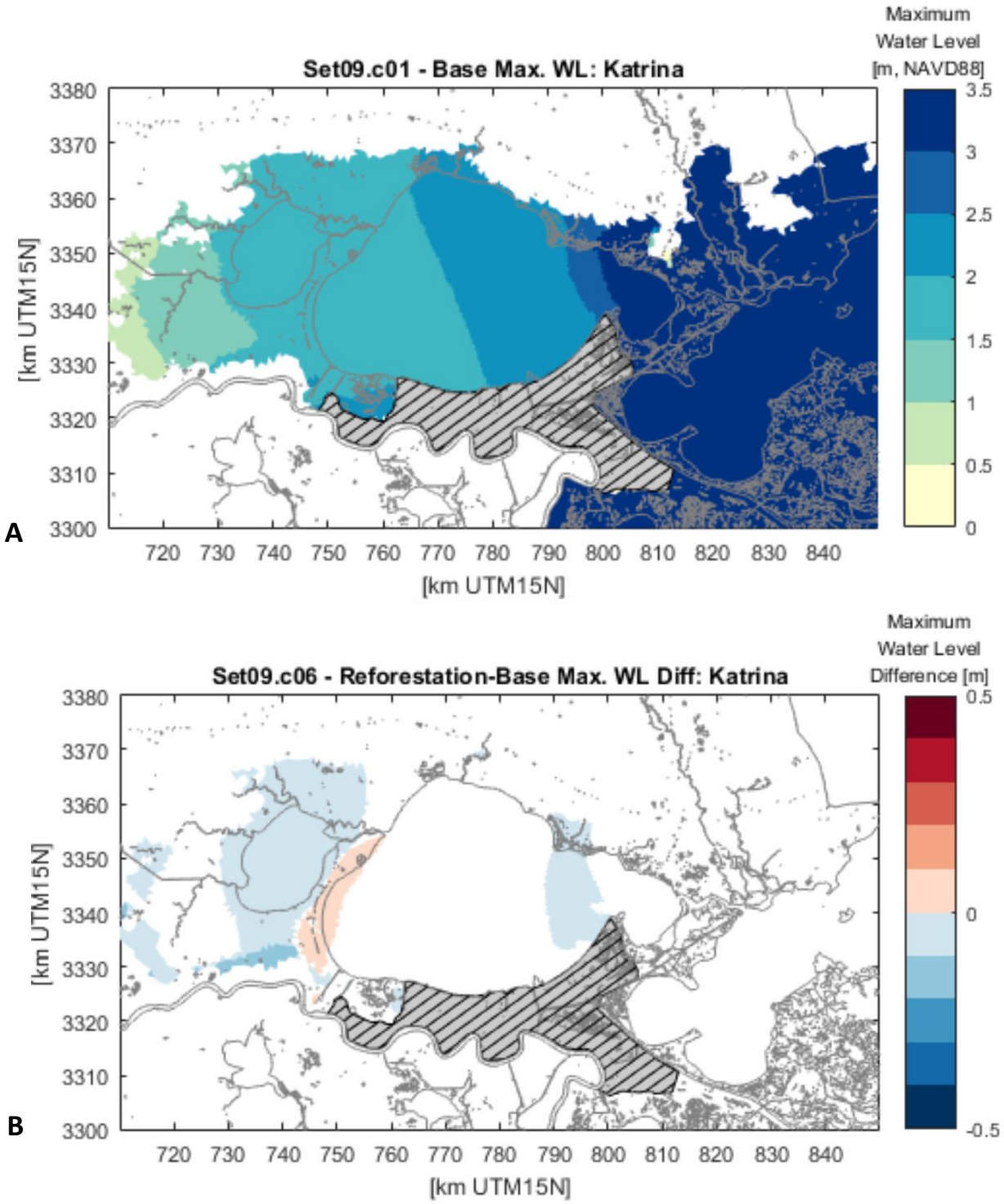
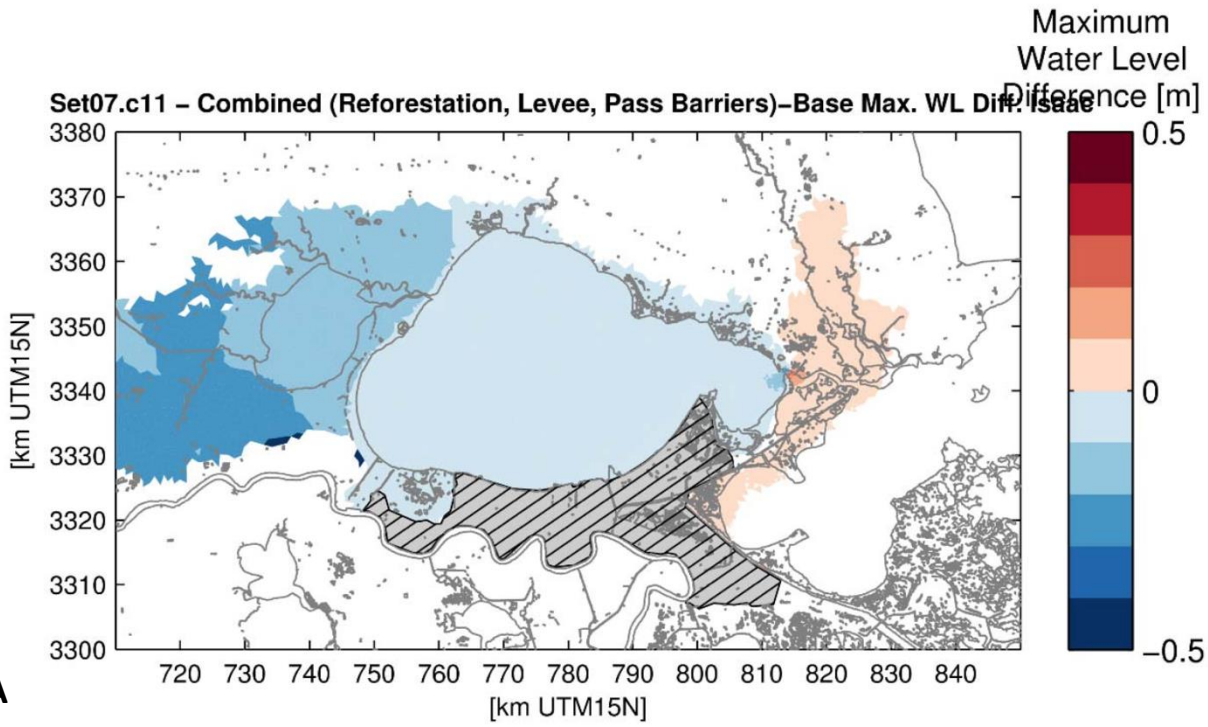


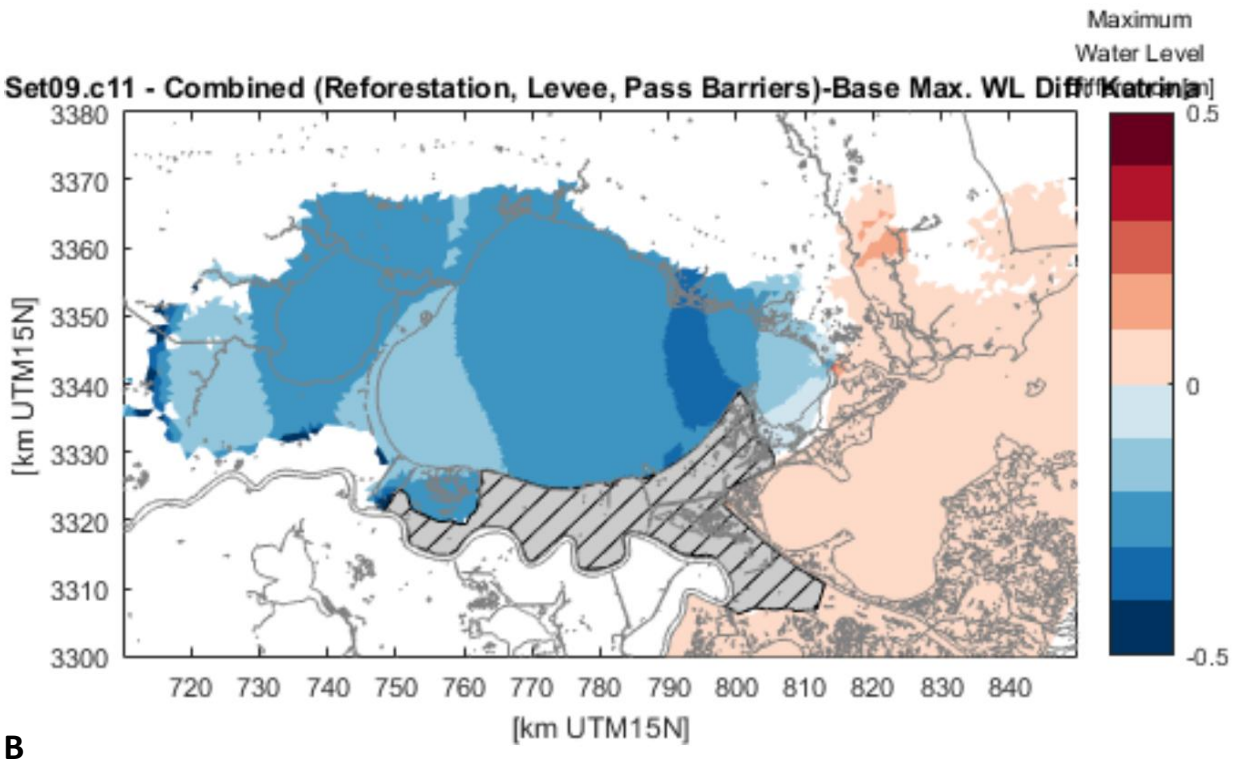
Fig. 3: A) Maximum water level from Hurricane Katrina using the present landscape. B) Difference in water level between the base case (water level in A) and the maximum water level with a reforested Maurepas land bridge.

The results of the modeling show a clear reduction in storm surge of about 10 cm (the areas west of the land bridge in both Hurricanes Isaac and Katrina. There is, however, an increase in surge level by about 10 cm. For Hurricane Isaac, this 10 cm increase is throughout Lake Pontchartrain. In the case of Katrina, the increase is over just the land bridge. Furthermore, there is a localized 20 cm reduction in surge level in both hurricanes in the vicinity of the planned West Shore Lake Pontchartrain levee. Clearly reforestation of the land bridge is beneficial to storm surge reduction.

The Maurepas land bridge, and its restoration to its historical condition as a swamp, is a key component in the region's defense against storm surge. The Multiple Lines of Defense System (Lopez, 2009) requires both manmade and natural features and works best when these features work in tandem. **Figure 4** illustrates this by combining several projects to see the effect on storm surge levels. The projects include the Maurepas land bridge reforestation, barriers on the Rigolets and Chef Menteur Passes, and the West Shore Lake Pontchartrain levee. From **Fig. 4a**, Hurricane Isaac, it's clear that surge reduction is most obvious at the Passes on the eastern side of the basin, and at the land bridge near the western side. The reduction in Hurricane Katrina (**Fig. 4b**) occurs throughout both Lakes Pontchartrain and Maurepas. **Figure 4** highlights the dramatic effect multiple projects, both man-made and natural, can have on surge height reduction.



A



B

Fig. 4: A) Difference in water level between the base case and the maximum water level with a reforested Maurepas land bridge, West Shore Lake Pontchartrain levee, and barriers on the Passes for Hurricane Isaac. B) Difference in water level between the base case and the maximum water level with a reforested Maurepas land bridge, West Shore Lake Pontchartrain levee, and barriers on the Passes for Hurricane Katrina

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