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Morganza Floodway: Soft Opening Scenarios

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INTRODUCTION: The Morganza Control Structure (MCS) is an important water management feature of the Mississippi River and Tributaries System. During extreme high-flow events, when the discharge past Baton Rouge is expected to exceed 1,500,000 cubic feet per second (cfs), water is diverted through the MCS, out of the Mississippi River in the vicinity of river mile 280, and into the Morganza Floodway to reduce the flow going past Baton Rouge and New Orleans. Completed in 1954, operation of the MCS has only occurred during the floods of 1973 and 2011 (USACE 2012). The Morganza Floodway is the area immediately downstream of the MCS, which hydraulically connects the diverted flow to the Atchafalaya River basin.

The widespread flooding within the Morganza Floodway during the 2011 Mississippi River Flood negatively affected wildlife. According to Section V of the Post-Flood Report (USACE 2012), ground-dwelling animals such as turkeys, deer, rabbits, armadillos, feral hogs, and bobcats attempt to flee floodwaters. Natural flooding events of bottom land hardwood forests see floodwaters rising on the order of inches per day, during which ground-dwelling animals search for higher ground. During 2011, floodwater depths occasionally increased on the order of feet per day, which resulted in observed animal fatalities. According to a study by Chamberlain et al. (2013), flow through the Morganza Floodway in 2011 negatively affected wild turkey populations through direct reductions in survival. Out of five tagged wild turkeys, only one survived to reach dry ground. On the other hand, black bears, which were recently delisted as an endangered species in 2016, were shown to be minimally affected by the 2011 flood (O'Connell-Goode et al. 2014). Approximately 89% of the black bears remained within the flooded area. During the flood, black bears denned up in trees and fasted for the duration of the flooding event. One female was struck by a train during the event, and it is presumed her cubs were lost as well (O'Connell-Goode et al. 2014).

The Morganza Floodway primarily consists of forest and agricultural lands. O'Connell-Goode et al. (2014) used barbed-wire hair sites to monitor black bears throughout the entire Morganza Floodway from Louisiana Highway 1 to U.S. Highway 190. In addition to wildlife living throughout the area, there is also a significant amount of agricultural (soybeans, corn, milo, sugarcane, etc.) and cattle production.

The investigation used the existing numerical model of the Morganza Floodway by Bell et al. (2017). The numerical code employed is the two-dimensional Adaptive Hydraulics (AdH) code. The Bell et al. (2017) model of the floodway was developed to accurately resolve the flood of 2011; all simulated water surfaces were within 1 foot (ft) of measured gage water surfaces for all gage locations. More detailed information about the development of the AdH model can be found in Bell et al. (2017). The purpose of this study was to simulate the timing and extent of lower discharge flooding events into the Morganza Floodway. These lower discharge events are referred to as *soft opening* and are intented to gradually fill the floodway providing wildlife an evacuation period from the area before high flow releases.

SIMULATIONS: The AdH model simulated three different flow rates entering the Morganza Floodway: 10,000 cfs; 25,000 cfs; and 50,000 cfs. For reference, the flow through the MCS peaked at approximately 170,000 cfs during the 2011 event. The design flow through the MCS during the Project Design Flood is 600,000 cfs. Thus, the flows simulated in this investigation are relatively low. All model simulation times are based on the initiation of flow at time zero. Side-by-side images of the results are shown in Figure 1 through Figure 6 at the same snapshots in time (1 hour, 4 hours, 8 hours, 12 hours, 24 hours, and 48 hours), which highlight the differences in inundation extents for each flow rate. Table 1 shows the approximate distance from the MCS, which the leading inundation front has reached for each time snapshot.

Table 1. Approximate inundation distance (feet from MCS).

Time	Inundation Extent, Length (ft) from MCS		
	10,000 cfs	**25,000 cfs**	**50,000 cfs**
1 hour	4,000	5,000	5,000
4 hours	9,300	11,300	13,300
8 hours	14,400	21,200	25,400
12 hours	21,700	29,500	33,800
24 hours	34,300	43,400	49,300
48 hours	47,100	79,400	> 90,000 (reached downstream limit)

Figure 1. Results at 1 hour for a) 10,000 cfs, b) 25,000 cfs, and c) 50,000 cfs.

(a)

(b)

(c)

Figure 2. Results at 4 hours for a) 10,000 cfs, b) 25,000 cfs, and c) 50,000 cfs.

Figure 3. Results at 8 hours for a) 10,000 cfs, b) 25,000 cfs, and c) 50,000 cfs.

(a)

(b)

(c)

Figure 4. Results at 12 hours for a) 10,000 cfs, b) 25,000 cfs, and c) 50,000 cfs.

Figure 5. Results at 24 hours for a) 10,000 cfs, b) 25,000 cfs, and c) 50,000 cfs.

(a)

(b)

(c)

Figure 6. Results at 48 hours for a) 10,000 cfs, b) 25,000 cfs, and c) 50,000 cfs.

DISCUSSION: The area downstream of the structure, up to approximately 20,000 ft away, is primarily forested. From 20,000 ft to 50,000 ft, there is much more agricultural land mixed with forest; at approximately 50,000 ft, it returns to mostly forested. Table 1 shows that even for the lowest discharge of 10,000 cfs, the flood water has propagated 20,000 ft within 12 hours. Notice that there is a large difference in the area of forest that has been inundated between the 10,000 cfs (Figure 4a) and 50,000 cfs (Figure 4c) at the time of 12 hours. This clearly demonstrates a benefit of much less land inundated for the 10,000 cfs scenario. Figure 6c shows that a discharge of 50,000 cfs inundates most of the floodway area by several feet within 48 hours. This indicates that a flood wave from a 50,000 cfs discharge likely propagates too quickly for ground-dwelling animals to evacuate to high ground. Of the three discharges simulated, the 10,000 cfs discharge shows the most potential for wildlife to successfully evacuate to high ground during the initial 48 hours. An even lower discharge would allow more time for animals to evacuate in front of the inundation front.

A slower initiation of water into the floodway may allow ground-dwelling animals a better chance to evacuate ahead of the floodwave, but there are a couple of factors that complicate this wildlife evacuation scenario. First, many locations that the animals would be expected to evacuate to become isolated and eventually fatal as the water continues to rise. Some of the highest ground is along the primary drainage channel toward the middle of the floodway; these locations eventually became flooded by several feet once the 2011 flood reached its peak. The second complicating factor is that animals that escape into the trees, such as black bears, would have to survive a much longer flooding duration event. Since black bears essentially fast during the flooding event, increasing the duration by introducing a low discharge event prior to the flood flow could negatively affect their survival. For these reasons, other engineering solutions for wildlife survival should also be studied, such as sanctuary mounds or higher constructed ground for evacuation routes.

SUMMARY: The AdH model simulated the initiation of constant flow rates into the Morganza Floodway predicting the inundation extents. As expected, inundation extents and depths increased as the inflow increased. The preceding maps are useful for demonstrating the propagation of the flood for various low discharge events into the Morganza Floodway. Of the three discharges simulated, 10,000 cfs is the most reasonable for allowing wildlife sufficient time to evacuate to higher ground. However, the soft opening scenarios are problematic since they increase the overall duration of the event for animals that are fasting (such as black bears), and animals that successfully find high ground initially may find themselves later in a fatally isolated position as the waters continue rising. The soft openings, along with other engineering solutions, should continue to be investigated to look for water management strategies that consider wildlife evacuation from the high-risk areas.

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