MINIMIZE HURRICANE SURGE PENETRATION INTO WEST /GALVESTON BAYS: It's CRUCIAL!

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Introduction: Hurricane storm surge enters the Galveston and West Bays through tidal passes and over the adjacent low-lying barrier islands once they become inundated. The shallower the water depth, the greater the influence of winds in pushing water, thereby forcing a storm surge. Once water gets inside the bays, because they are so shallow, hurricane force winds move it around very rapidly and effectively. Winds push water from one side of the bay to the other, tilting the water surface. Water level is elevated on the downwind side/lowered on the opposite upwind side. At any one time elevations on opposite sides of Galveston Bay (east and west) can differ by 10 ft or more. The location of highest elevated surge can change quickly as the eye of the storm moves through the region and wind direction changes rapidly. Because of the prevailing counterclockwise wind circulation about the hurricane's eye, which is present in all hurricanes, the west sides of both bays tend to experience the brunt of locally elevated surges within the bays as hurricanes approach the north Texas coast from the southeast.

The Ike Dike concept that is being advocated by Dr. William Merrell, Texas A&M University at Galveston, and its research partners, functions by keeping storm surge from entering the shallow bays, minimizing the amount of water that resides within the bays which can be pushed by hurricane winds. The concept involves construction of storm surge gates at both Bolivar Roads and San Luis Passes, and construction of land barriers on Galveston Island, Bolivar Peninsula, and Follets Island. The concept functions well by minimizing surge forerunner penetration through the passes (water entry) in the days leading up to landfall, by minimizing peak surge penetration through the passes (more water entry) as the hurricane approaches landfall, and by minimizing overtopping of the barrier islands (still more water entry). The land barriers delay the onset of barrier island overtopping and overflow, reducing the duration and magnitude of water that enters the bays via these pathways. The Ike Dike concept does not alter the hurricane force winds; subsequent tilting of the water surface still occurs within the bays. So, it is crucial to minimize the amount of water inside the bays to maximize effectiveness of a coastal spine which "defends" at the coast.

Objectives: The coastal spine that emerged as the Tentatively-Selected Plan (TSP) in the U.S. Army Corps of Engineers (USACE) Coastal Texas Study, is quite similar to the Ike Dike concept, with one key difference. The TSP's coastal spine stops at the west end of Galveston Island, it does not include a gate at San Luis Pass, nor does it include a land barrier on Follett's Island. Both features are included as a western section of the Ike Dike concept. Omission of the western section in the USACE TSP leaves a "back door" open, for surge to penetrate into both West and Galveston Bays, thereby increasing peak surge levels in both bays and increasing flood risk to all the areas that lie "behind" the coastal spine. The objective in this presentation is to illustrate and quantify the consequences of leaving the "back door" open.

Results: In the absence of a western section, the hurricane surge forerunner (which can reach elevations in excess of 6 ft well before landfall) propagates through San Luis Pass, into both West and Galveston Bays utilizing the deeper channels, and propagates into the upper reaches of the Houston Ship Channel. The importance of the forerunner for this project, in this region, should not be understated. The forerunner has significant implications for project formulation, design and gate operations. The open-coast forerunner is attenuated through San Luis Pass and further attenuated between West and Galveston Bays, but the attenuated forerunner still enters Galveston Bay.

Even with attenuation, a 1 to 1.5 ft forerunner amplitude in Galveston Bay is possible for severe storms (perhaps more), leading to peak surge increases of roughly 2 to 3 ft (perhaps more), which are capable of significantly increasing damage/losses in both Bays. Increases of peak surge by 2 to 3 feet can significantly increase the size of areas that experience inundation and damage, and increase the level of damage two- or three-fold in inundated areas. Forerunner penetration into both bays, and its consequences, are amplified by rising sea level.

In the absence of a western section, peak surge due the hurricane's core winds as it approaches and makes landfall does an "end run" around the western end of the proposed TSP and significantly increases flood risk to Galveston Island and the north shore of West Bay, subjecting these areas to undue flooding, even for relatively frequent, lower intensity hurricanes. Flood risk throughout the entire Houston-Galveston region that lies behind the coastal spine is increased by leaving the "back door" open. The western dike section provides flood risk reduction benefits throughout both West and Galveston Bays. Leaving the back door open also, presumably, increases the required crest elevation and costs for all secondary lines of defense that are built behind the coastal spine. The USACE TSP specifically identified these secondary measures: ring dike around the bay side of the City of Galveston, surge gate at the entrance to the Dickinson community, and a surge gate at the entrance to the Clear Lake community. Both direct flood risk reduction benefits and cost avoidance on secondary flood risk reduction measures should be accounted for in a cost/benefit analysis and the subsequent decision to include a western section or omit it in the TSP.

Minimizing the amount of water that resides within the bays when the surge barrier is closed, which is crucial for the Ike Dike concept to work most effectively, is somewhat compromised by omitting the western section. A gate at San Luis Pass, along with a gate at Bolivar Roads, enables forerunner penetration to be mostly curtailed, particularly with closure at low tide that serves to minimize the amount of water that resides within the bays prior to a hurricane strike.