Forecasting Coastal Change under Sea Level Rise: A Mid-Atlantic Case Study

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Quantifying Risks of Climate Change and Sea Level Rise to Naval Station Norfolk

In the next century, military assets, capabilities, and operations will be directly affected by inundation due to sea level rise and resulting changes in wave energy and storm surge. Furthermore, indirect effects of geomorphic evolution and resultant changes in ecological communities could magnify direct impacts.

Military installations require risk assessment methods to prioritize adaptive actions in light of sea level change. As part of a sea level rise risk assessment at Naval Station Norfolk, Virginia (Figure 1, Burks-Copes and Russo, forthcoming), we conducted simulations of potential changes in wetland extent and type.

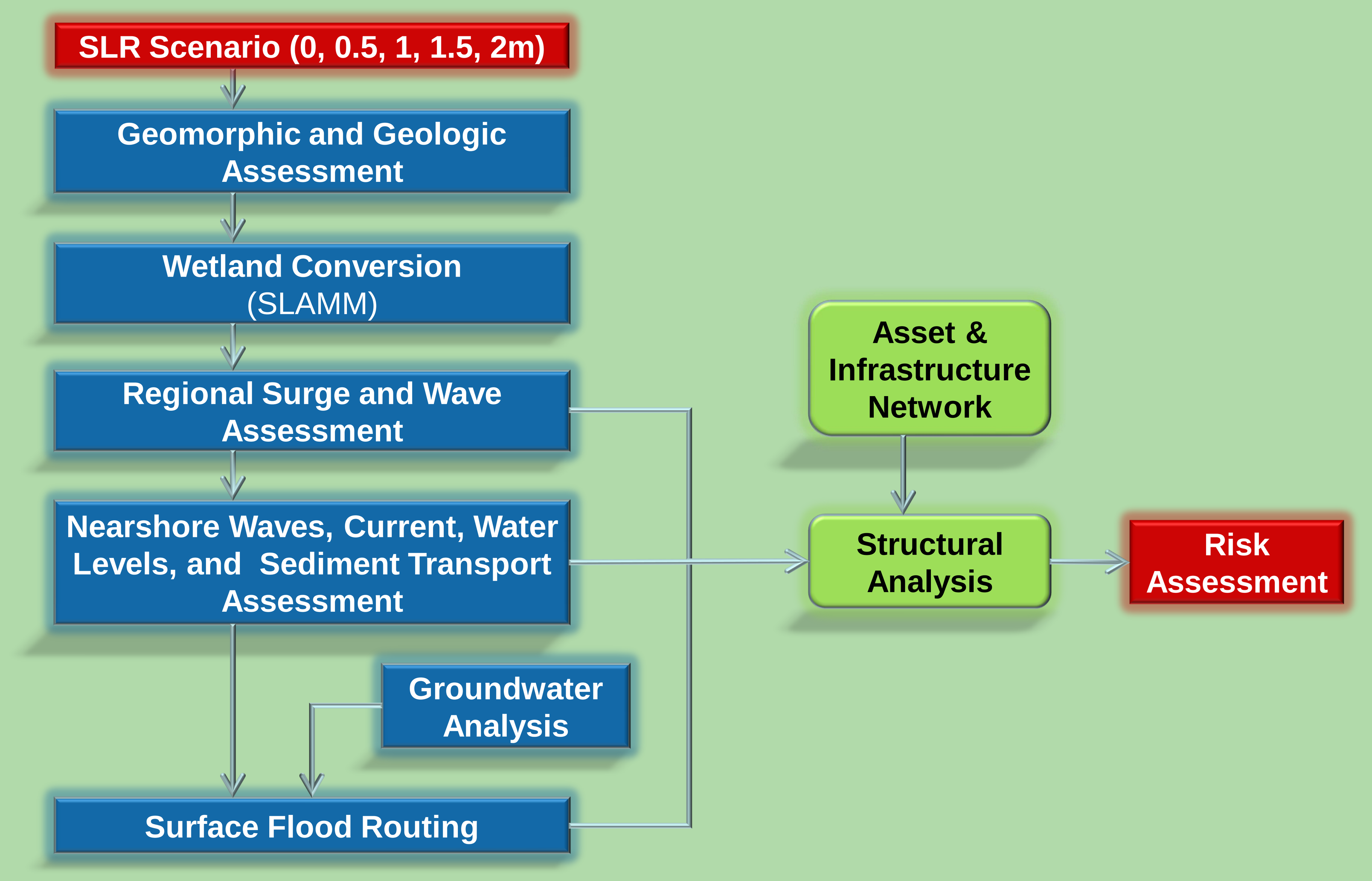

Figure 1. Conceptual model of sea level rise risk assessment at Naval Station Norfolk.

Sea Level Affecting Marshes Model (SLAMM)

Wetland evolution in the Norfolk region was forecasted using the Sea Level Affecting Marshes Model (SLAMM) for a 100-year time period with five incremental levels of sea level rise (0.0m, 0.5m, 1.0m, 1.5m, and 2.0m). SLAMM applies user-defined rules to account for key processes associated with wetland evolution: soil inundation, erosion, marsh accretion, barrier island overwash, and soil saturation. The model also accounts for presence or absence of coastal protection structures such as sea walls or levees.

We updated Glick et al.'s (2008) application of SLAMM to the Norfolk region based on newly available data from the National Wetland Inventory, a new topographic-bathymetric map from the Federal Emergency Management Agency, an updated coastal protection database, and a new version of the model (SLAMM 6.0 v. SLAMM 5.0).

We assessed model sensitivity relative to two critical inputs: (1) coastal protection strategy and (2) physical process rates. Figure 2 presents coastal change for our sensitivity scenarios, where S1 is the expected future, S2 and S4 examine alternative protection strategies, and S5, S6, and S7 examine alternative parameterizations of ecological and physical process rates.

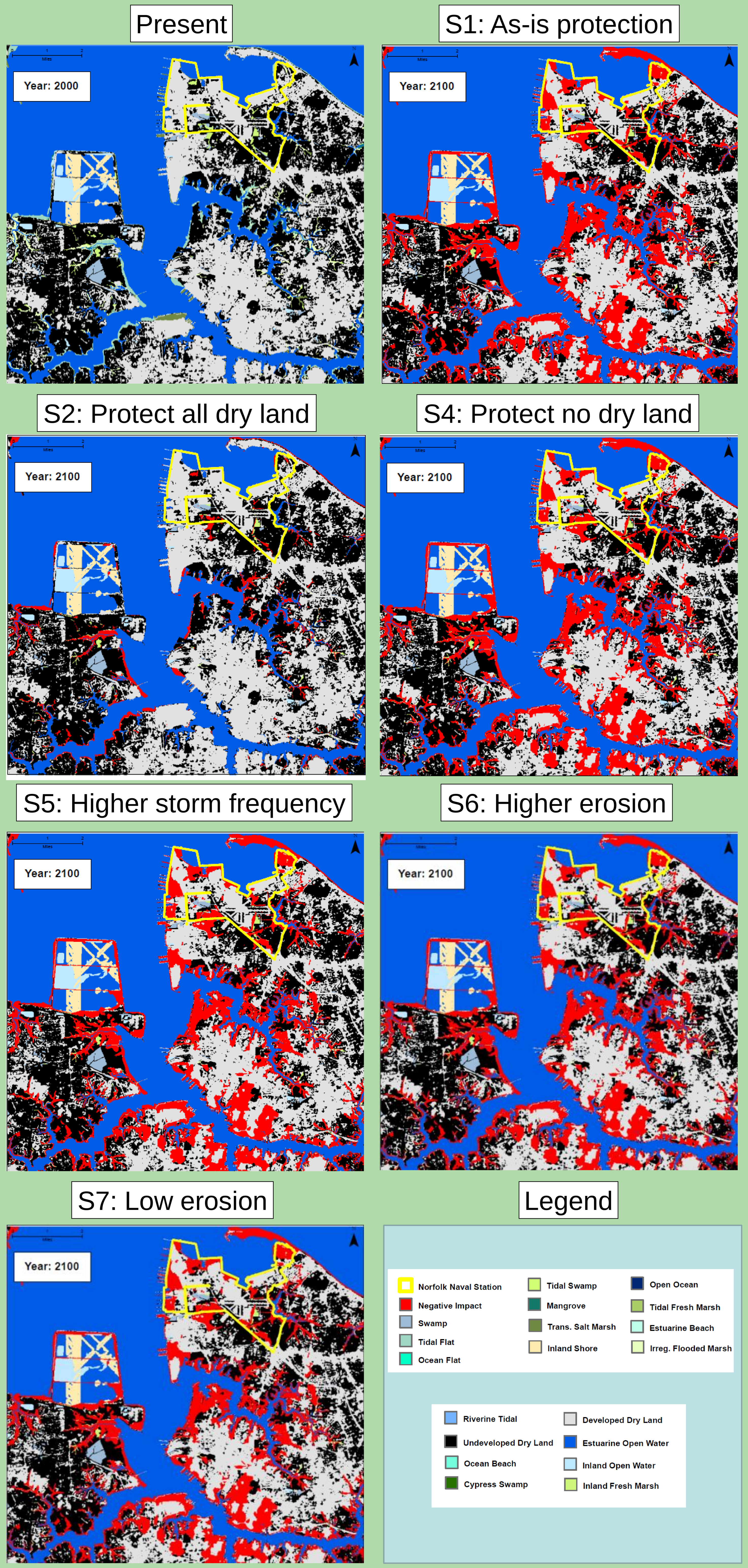

Figure 2. Land use change under alternative SLAMM parameterization scenarios with 2 meters of SLR in Year-2100. The first figure represents baseline conditions in Year-2000.

Model Results

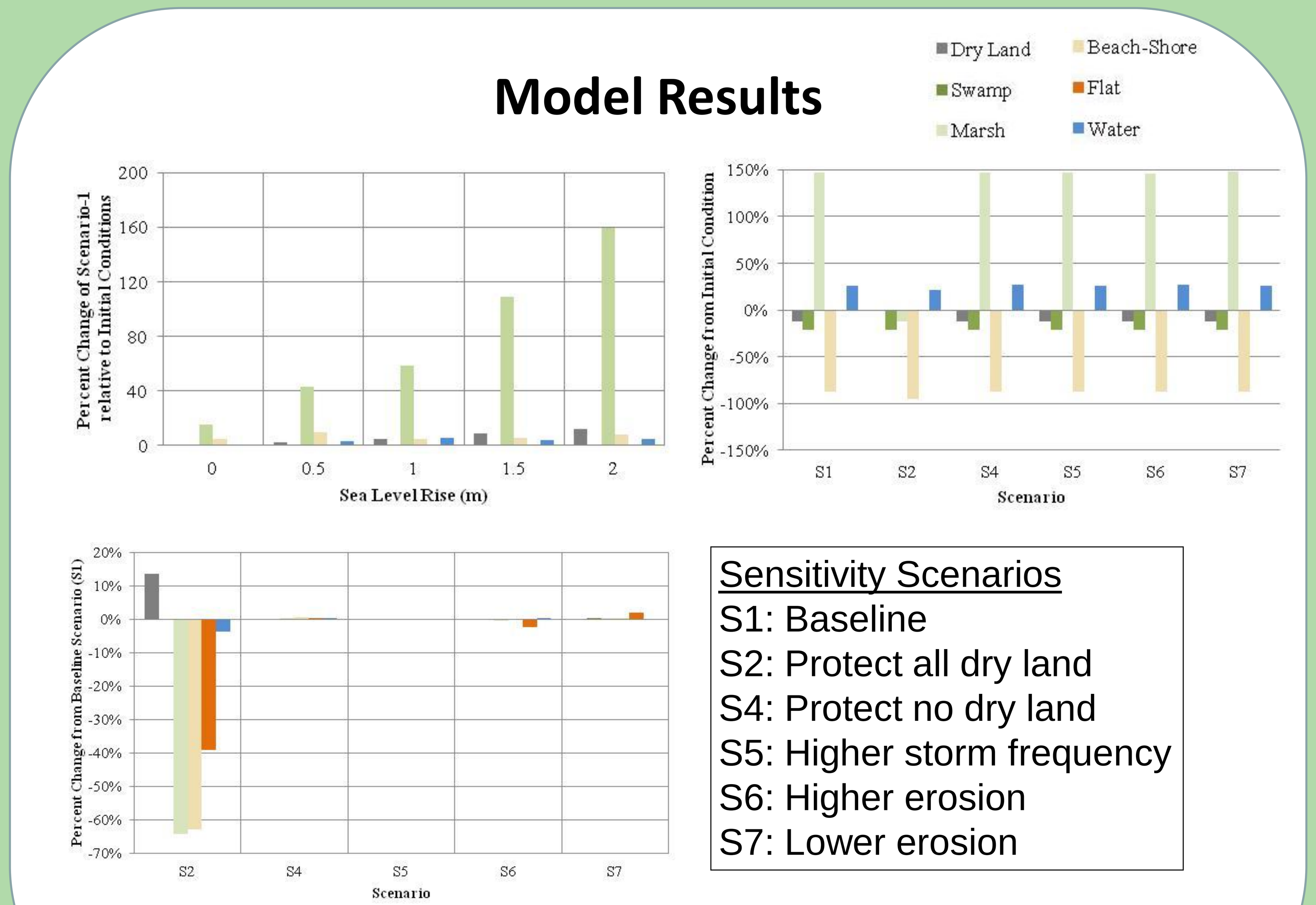

Figure 3. Relative change in land cover for 5 sea level rise simulations and sensitivity analyses at 2 meters sea level rise. Note: there is zero initial acreage of flat, which prevented a relative comparison to the initial conditions.

Conclusions

•For the highly developed Norfolk site, SLAMM predicts dry land, swamp, and beach/shore to decrease and marsh, flat, and open water to increase.

•SLAMM is highly sensitive to social decisions regarding protection of land (e.g., levee construction or retreat) and minimally sensitive to ecological or physical process inputs (e.g., accretion and erosion rates).

•Model sensitivity analysis is critical in long-term forecasts of coastal change, such as those required to assess sea level rise.

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Key References

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