Section 5: Conclusions

Sea level rise driven by global climate change is a clear and present risk to the United States, now and for the foreseeable future. It is the goal of the Sea Level Rise and Coastal Flood Hazard Scenarios and Tools Interagency Task Force to continue to provide projections and future scenarios to assist decision-makers for both planning and risk-bounding purposes. This report builds upon the progress made in Sweet et al. (2017), updating the GMSL scenarios and the associated local and regional RSL projections to reflect recent advances in sea level science, as well as expanding the types of scenario information provided to better serve stakeholder needs for coastal risk management and adaptation planning.

The major findings of this report are as follows:

Multiple lines of evidence provide increased confidence, regardless of the emissions pathway, in a narrower range of projected global, national, and regional sea level rise at 2050 than previously reported (Sweet et al., 2017).

Both trajectories assessed by extrapolating rates and accelerations estimated from historical tide-gauge observations, and model projections, fall within the same range in all cases, giving higher confidence in these relative sea level (RSL; land and ocean height changes) rise amounts by 2050. Specifically, RSL along the contiguous U.S. (CONUS) coastline is expected to rise, on average, as much over the next 30 years (0.25–0.30 m over 2020–2050) as it has over the last 100 years (1920–2020). Due to processes driving regional changes in sea level, the report found regional differences in both the modeled scenarios and observation-based extrapolations, with higher RSL rise along the East (0–5 cm higher on average than CONUS) and Gulf Coasts (10–15 cm higher) as compared to the West (10–15 cm lower) and Hawaiian/Caribbean (5–10 cm lower) Coasts.

For coastlines outside CONUS, and for individual regions and locations within CONUS, the projections can differ from the aforementioned mean values. In addition, it is important to note that the projections do not include natural year-to-year sea level variability that occurs along U.S. coastlines in response to climatic modes such as the El Niño–Southern Oscillation. Nevertheless, if we assume that regional sea level will keep following its present trajectory for the coming three decades, most U.S. regions are mostly tracking between the Intermediate-Low and Intermediate-High scenarios. Although the near-term observation-based extrapolations will continue to evolve over time with new observations and analyses, this updated information should help inform both near-term decisions and projects that may require decades' worth of planning prior to actual implementation.

By 2050, the expected relative sea level (RSL) will cause tide and storm surge heights to increase and will lead to a shift in U.S. coastal flood regimes, with major and moderate high tide flood events occurring as frequently as moderate and minor high tide flood events occur today. Without additional risk-reduction measures, U.S. coastal infrastructure, communities, and ecosystems will face significant consequences.

Minor/disruptive high tide flooding (HTF; about 0.55 m above mean higher high water [MHHW]) is projected to increase from a U.S average frequency of about 3 events/year in 2020 to >10 events/year by 2050. The projected increases for moderate/typically damaging (about 0.85 m above MHHW) and major/often destructive (about 1.20 m above MHHW) HTF are 0.3 events/year in 2020 to about 4 events/year in 2050 and 0.04 events/year in 2020 to 0.2 events/year by 2050, respectively. Across all severities (minor, moderate, major), HTF along the U.S. East and Gulf Coasts will largely continue to occur at or above the national average frequency.

In other words, much of the coastline is already close to a flood regime shift with respect to flood frequency and, consequently, damages. Only a small height difference (0.3–0.7 m) currently separates infrequent, damaging, or destructive HTF from the current regime of more frequent, so-called nuisance, flooding (whose impacts are in fact already remarkable throughout dozens of densely populated coastal cities). Decades ago, powerful storms were what typically caused coastal flooding, but due to RSL rise, even today's common wind events and seasonal high tides are already regularly flooding communities, and they will do so to an ever greater extent in the next few decades, affecting homes and businesses, overloading stormwater and wastewater systems, infiltrating coastal groundwater aquifers with saltwater, and stressing coastal wetlands and estuarine ecosystems.

Higher global temperatures increase the chances of higher sea level by the end of the century and beyond. The scenario projections of relative sea level (RSL) along the contiguous U.S. (CONUS) coastline are about 0.6–2.2 m in 2100 and 0.8–3.9 m in 2150 (relative to sea level in 2000); these ranges are driven by uncertainty in future emissions pathways and the response of the underlying physical processes.

With an increase in average global temperature of 2°C above preindustrial levels, and not considering the potential contributions from ice-sheet processes with limited agreement (low confidence) among modeling approaches, the probability of exceeding 0.5 m rise globally (0.7 m along the CONUS coastline) by 2100 is about 50%. With 3°–5°C of warming under high emissions pathways, this probability rises to >80% to >99%. The probability of exceeding 1 m globally (1.2 m CONUS) by 2100 rises from <5% with 3°C warming to almost 25% with 5°C warming. Considering low-confidence ice-sheet processes and high emissions pathways with warming approaching 5°C, these probabilities rise to about 50%, 20%, and 10% of exceeding 1.0 m, 1.5 m, or 2.0 m of global rise by 2100, respectively. While these low-confidence ice-sheet processes are unlikely to make significant contributions with 2°C of warming, how much warming might be required to trigger them is currently unknown.

In addition, as a result of improved understanding of the timing of possible large future contributions from ice-sheet loss, the "Extreme" scenario from the 2017 report (2.5 m GMSL rise by 2100) is now viewed as less plausible and has been removed from consideration. Nevertheless, the increased acceleration in the late 21st century and beyond means that the other high-end scenarios provide pathways that potentially reach this threshold in the decades immediately following 2100 (and continue rising). Regionally, the projections are near or higher than the global average in 2100 and 2150 for almost all U.S. coastlines due to vertical land motion (VLM); gravitational, rotational, and deformational effects due to land ice loss; and ocean circulation changes. Largely due to VLM, RSL projections are lower than the global amounts along the southern Alaska coast and are higher along the Eastern and Western Gulf coastlines.

Monitoring the sources of ongoing sea level rise and the processes driving changes in sea level is critical for assessing scenario divergence and tracking the trajectory of observed sea level rise, particularly during the time period when future emissions pathways lead to increased ranges in projected sea level rise.

Efforts are currently under way to narrow the uncertainties in ice-sheet dynamics and future sea level rise amounts in response to increasing greenhouse gas forcing and associated global warming. Early indicators of changes in sea level rise trajectories can serve to trigger adaptive management plans and are identified through continuous monitoring and assessment of changes in sea level (on global and local scales) and of the key drivers of sea level change that most affect U.S. coastlines, such as ocean heat content, ice-mass loss from Greenland and Antarctica, vertical land motion, and Gulf Stream system changes.

As emphasized in the summary findings above, beyond 2050 the amount of sea level rise is strongly affected by future global warming. By reducing greenhouse gas (GHG) emissions, severe and transformative impacts occurring later this century or early next century along U.S. coastlines are more likely to be avoided. As GHG emissions and global temperatures continue to rise, the likelihood of very high U.S. sea level rise does too. If global warming reaches 2°C (warming levels are already >1°C), corresponding to a 50% chance that U.S. sea level as a whole will rise at least 0.7 m by 2100 and 1.2 m by 2150 (measured since 2000), major HTF by 2100 would occur more often than minor HTF occurs today in many coastal communities if risk-reduction action is not taken. If global mean temperatures were to rise as high as about 3°–5°C, much larger amounts of sea level rise would become increasingly possible, as instabilities in ice-sheet dynamics would potentially come into play. Constant monitoring of global to local sea levels and their source contributions by Federal agencies, such as NOAA and NASA, will be key to help assess potential trajectory divergence for triggering adaptive management plans.

The updated sea level scenarios and the EWL probability datasets in this study are being delivered or planned via numerous agency data servers, tools, and associated guidance products. Additionally, this report is a key technical input to the Fifth National Climate Assessment (NCA5 currently under way), and the datasets and derived information are being delivered to the NCA5 author teams. In terms of next steps, the Task Force will continue to refine these sea level projections and extreme (e.g., high tides, storms) water level probabilities while working to improve understanding of the implications of these projections for coastal hazards (e.g., flooding, erosion, and rising water tables), societal exposure and risk, infrastructure vulnerability, ecosystem health (including habitat transformation/loss), and cascading societal impacts. In order to do so, additional and improved observations and more sophisticated modeling approaches that incorporate the relevant physical processes (e.g., waves; see Box 3.1) will be needed at the regional scale, with local granularity to assess the impacts of these coastal hazards. Such information is expected to ultimately feed into the next generation of interagency reports and assessments to enable informed climate adaptation planning.