# Puget Sound - Coastal Storm Modeling System (PS-CoSMoS)

The Coastal Storm Modeling System (CoSMoS) makes detailed predictions of storm-driven coastal flooding, erosion, and cliff failures that can be visualized using standard map viewers. These coastal flooding predictions can be provided for large geographic areas (e.g., Puget Sound, the Straits, and the outer coast), mappable at scales fine enough to use for planning purposes. CoSMoS was developed to be useful for exploring past, present, and future coastal hazards: it can be used to perform "hindcast" studies to better understand historical events, support operational (real-time) applications to support emergency response, and generate future scenario-based coastal flooding simulations to support local coastal hazards and sea-level rise vulnerability planning. PS-CoSMoS will provide information that can used to increase public safety, mitigate physical damages, and more effectively manage and allocate resources within complex coastal settings.

What is CoSMoS?

The Coastal Storm Modeling System (CoSMoS) is a modeling system developed by the United States Geological Survey (USGS) to provide robust and detailed predictions of coastal flooding due to future sea level rise and storms, integrated with long-term coastal evolution (i.e., beach changes and cliff/bluff retreat) over large geographic areas (100s of kilometers). CoSMoS accounts for all the relevant physics of a coastal storm (e.g.,tides, waves, and storm surge), which are then scaled down to local flood projections for use in comunity-level coastal planning and decision-making. In future scenario mode, CoSMoS uses wind and pressure from global climate models to project coastal storms under changing climatic conditions projected for the 21st century. In operational mode, CoSMoS uses real-time weather data and forecasts to predict imminent flooding conditions.
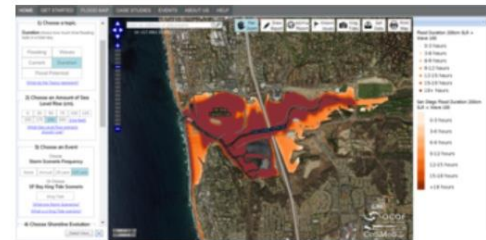
Example of CoSMoS model output for San Diego showing duration of flooding. Results displayed on Our Coast, Our Future flood mapper.

What is the goal of Puget Sound-CoSMoS?

PS-CoSMoS will deliver consistent, detailed, and scientifically-credible storm-driven flooding and flood impact predictions, detailed enough to be mapped to support local planning needs, and comprehensive enough to cover the entire Puget Sound shoreline. Flood and impact predictions are viewed using an interactive web tool and GIS-friendly files for projections of coastal flooding extent, depth, and elevation, as well as maximum waves, currents and ecosystem impacts (e.g., coastal change impacts to marshes, shellfish beds, forage fish spawning beaches, etc.) for a variety of scenarios of SLR and coastal storm intensities. The web tool will translate the physical exposure to coastal hazards for each scenario into socioeconomic impacts, including jurisdictional breakdowns of population exposure and economic impacts.

Why was it developed?

CoSMoS was developed to provide regionally-consistent, but locally-relevant, detailed storm impacts projections for coastal communities using state-of-the-art coastal hazards science. Coastal communities are facing more intense and frequent coastal flooding-related impacts and are planning for increasing coastal hazards in the future. CoSMoS was developed to simulate the complex interactions of storm-driven wind and waves, within a framework that brings together the important drivers of coastal flooding hazards, including factors that are changing with sea-level rise and increasing winter storm intensities.

Why the focus on storms with sea-level rise?

Anticipated increasing coastal flooding impacts from sea-level rise include not only those associated with the long-term impacts of additional tidal flooding (chronic, nuisance flooding) but also short-term (but more damaging) storm-related impacts resulting from higher storm-surge, waves, currents and concurrent river flooding (highly-damaging large flood events). It is important to note that while tidal height increases incrementally with sea-level rise, storm surge and storm wave heights can increase well beyond the incremental addition of sea-level rise, because of the reduced resistance of the seafloor on the surge and waves. Recent work suggests that today's 100-yr coastal flooding event will become a 10-yr event with just 1 ft of SLR and a 1-yr event with 2 ft of rise. The Washington Coastal Resilience Project's (WCRP) has recently released sea-level rise projections for Washington State coast lines, suggesting that coastal hazards will increase significantly in the coming decades.   Without the consideration of coastal storms, present and future coastal vulnerability assessments greatly underestimate flooding risk.

How does CoSMoS estimate socio-economic impacts of coastal flood events?

To support coastal communities in their planning, CoSMoS links up its flooding projections with a flood damage estimation model, the USGS Hazards Exposure Reporting and Analytics (HERA) application. HERA projects the exposure and expected losses of residents, businesses and infrastructure within CoSMoS flooding scenarios. These impacts can be mapped within the HERA tool at various scales of interest. This partnership of expertise in simulating coastal processes and hazards and estimating socio-economic risk and impacts allows the creation of an interactive website application that directly supports real-world coastal hazards planning, mitigation, and response.
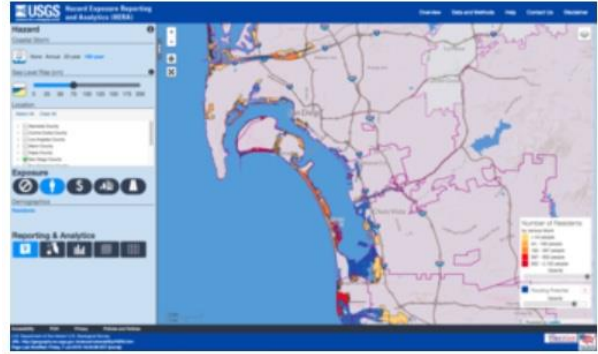
Example of Hazards Exposure Reporting and Analytics (HERA) analysis for San Diego.

Has CoSMoS been used elsewhere?

The CoSMoS model has been successfully applied in the State of California, including the north-central coast (Half Moon Bay to Pt. Arena), San Francisco Bay, the central California coast, and southern California. The north coast of California will follow with expected completion by the end of 2019. All modeling results are available as GIS shapefiles, with accompanying metadata, at USGS ScienceBase-Catalog. CoSMoS information can also be accessed, viewed, and downloaded through the Our Coast, Our Future (OCOF) flood mapper, which provides a user-friendly web-based tool for viewing all model results. OCOF also provides resources and guidance for helping communities navigate and utilize the wealth of information provided by CoSMoS.

What makes CoSMoS unique?

• Detailed modeling of all the relevant physics (e.g., tides, waves, surge) of a coastal storm integrated with local coastal flooding models, supporting storm-driven coastal flooding predictions and mapping under sea-level rise;

• Incorporates information from the latest Global Climate Models to drive regional models wind, pressure, and waves for a chosen sea-level and storm intensity, reflecting state-of-the-art climate science;

• Incorporates scenario-based planning based on a broad range of user-chosen sea-level rise and coastal storm intensity (daily to 100-year return) to meet anticipated planning horizons within a customizable flood risk framework.

• Provides web tools that allow users to select, visualize and download the flooding depth, extent, and uncertainty associated with each event, in addition to predictions of wave heights, current strength, and ecosystem impacts for 40 combinations of SLR and storms. The tool seamlessly integrates databases of socioeconomic, ecologic, land use and infrastructure projections to allow decision-makers to explore flood impacts.

Where can I get more information?

• Puget Sound CoSMoS Website - https://walrus.wr.usgs.gov/coastal_processes/cosmos/puget/
• USGS CoSMoS Website- http://walrus.wr.usgs.gov/coastal_processes/cosmos/
• Online report- 'The Framework of a Coastal Hazards Model—A Tool for Predicting the Impact of Severe Storms': http://pubs.usgs.gov/of/2009/1073/
• Online tools- *Our Coast, Our Future- Interactive Map* showing CoSMoS=predicted flooding impacts for the California Coast and San Francisco Bay (in partnership with Point Blue and NOAA): www.ourcoastourfuture.org

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