AN UPDATE ON NEW HAMPSHIRE SEA LEVEL RISE

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If you have applied for a state and local environmental permits recently in the New Hampshire seacoast, you will have noticed the rules require design for more extreme rainfall and accelerating sea level rise. As these rules may restrict what you can do on your property and may adversely impact your property value, we should be asking if these extreme forecasts of future conditions are accurate. This review looks at the promulgating laws and how the accelerating sea levels projected, don't match up with actual observed data. The acceleration projections are already significantly higher than observed sea level data, and the divergence is increasing.

In 2013 the New Hampshire Senate passed Bill SB 163, Chapter 188 which established a New Hampshire Coastal Risk & Hazards Commission to prepare for projected sea level rise and other coastal hazards. This was followed in 2016 with Senate Bill SB 452 requiring state agencies to make changes to statues, rules and policies to prepare for coastal flood risks using the best available projected coastal flooding risks, such as the 2014 Coastal Risks & Hazards report.

The first 2014 Coastal Risks & Hazards (CRH) report adopted projection curves developed by National Oceanic and Atmospheric Administration (NOAA), with acceleration in sea level rise starting in 1992. This report indicated that projects with high tolerance for flood risk to commit to 3.9 feet of sea level rise and prepare for 6.6 feet of sea level rise by 2100. Projects with low tolerance for flooding should commit to 6.6 feet of sea level rise by 2100. It is significant to note that by the time the 2014 CRH report was issued, the outdated sea level rise acceleration projections were above the observed sea level rise. It is apparent that the rise acceleration curves were not recalibrated to better fit the 22 years of sea level rise observations after 1992 that existed prior to the CRH report release.

In 2020 the Coastal Risks & Hazards report was updated and issued by the University of New Hampshire (UNH) and the New Hampshire Department of Environmental Services (NHDES) in two volumes in late 2019 and early 2020[1]. This report adopted sea level rise acceleration curves starting in 2000, and assigned Bayesian probabilities to the different sea level rise projection curves. For residential and commercial buildings they assign a "95% probability" category with 1.6 feet of sea level rise by 2050 and 3.8 feet of sea level rise by 2100. Note that Bayesian probabilities include the use of opinion and extrapolation modelling, and these probabilities are different from observational data based probabilities, such as used to establish FEMA 100 year (1%) flood elevations. Other governmental climate change forecasting reports also use Bayesian probabilities, but are usually careful not to assign specific percentages, preferring to use more vague term, such as "likely".

The 2020 CRH report, like the prior report, presents sea level rise acceleration curves, but with the rise acceleration beginning in 2000. As this report was not issued until 2020, we have the opportunity to see how 21 years of actual sea level rise compares to the forecasted acceleration curves. Figure 1 plots the 2020 CRH acceleration curves ("UNH") and projected acceleration curves by the US Army Corps of Engineers and NOAA, in comparison with actual sea level rise observed by global tide stations, global satellite sea level rise data and locally observed sea level rise in Portland, Maine (the reference tide gauge for most NH tide prediction locations).

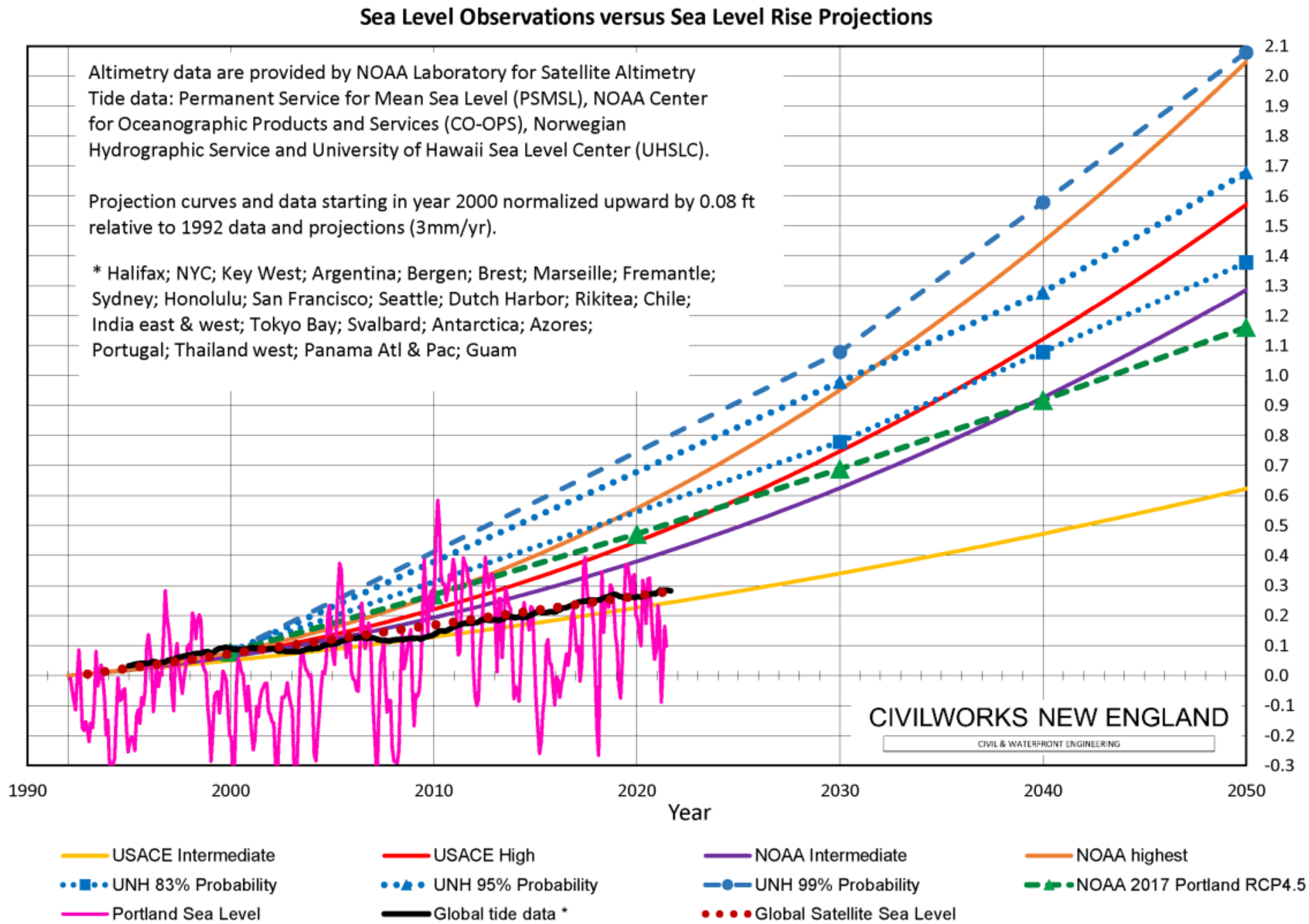

Figure 1 Sea Level Rise Observations Compared to Various Sea Level Rise Projections

Actual Sea Level Rise Trend:

The Portsmouth Harbor NOAA tide station (currently at Seavey Island) has extensive data gaps (many years) where no data were collected and rise trend data has been mixed with New Castle tide data having a different tidal range. The NOAA tide station in Portland, Maine, however does have continuous observed tide levels since 1912. The Portland tide station sea level rise trend reported by NOAA has an average linear rise of 1.9 mm/year (0.6 ft/100 yrs), based on actual long term water level observations.

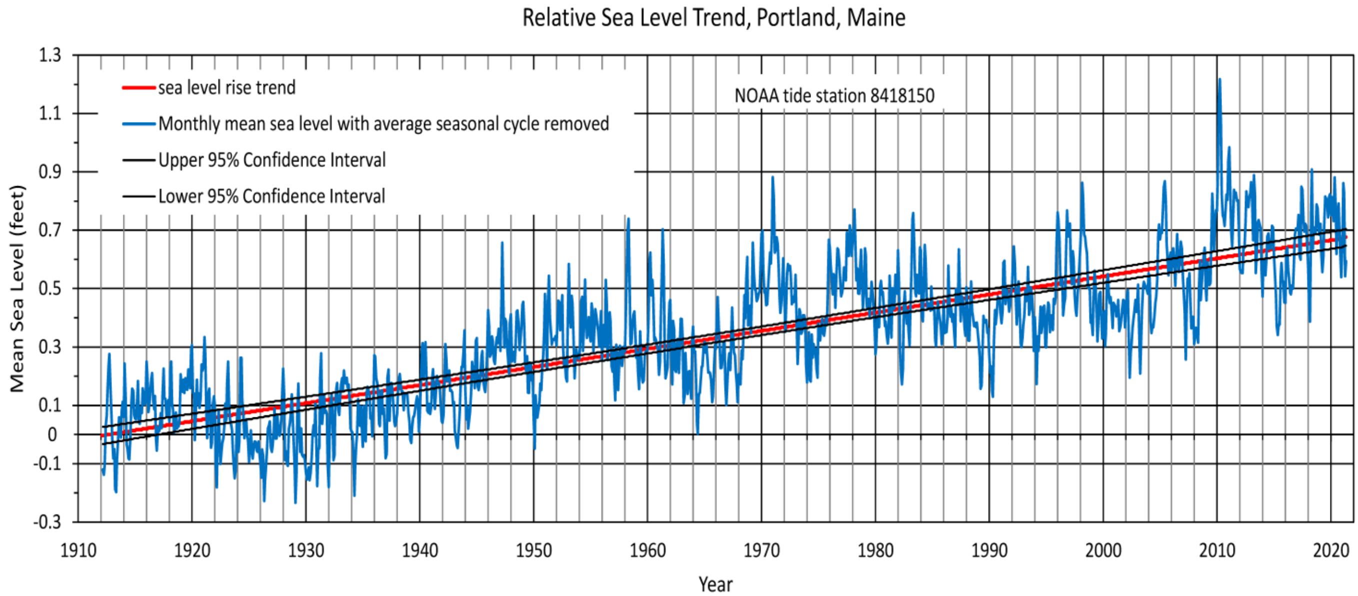

Figure 2 Sea Level Rise Trend NOAA Tide Station, Portland, Maine

Civilworks New England (CNE) has been evaluating the rate of sea level at many long record global tide gauges, including New England tide data. We find that the rate of sea level rise, over a 19-year tidal epoch rolling window, varies over time. This oscillatory variation in rate of sea level rise and fall has similar trends at regional tide stations and those cyclical trends have strong correlations to the 60-year cycle in sea surface temperature anomalies (Atlantic Multidecadal Oscillation (AMO)), variation in the Length Of Day (LOD, variation in the spin rate of Earth) and to the eccentricity of Jupiter's orbit, which has been tied to increases in space dust entering our atmosphere, cloud cover and climate[2], see Figure 3.

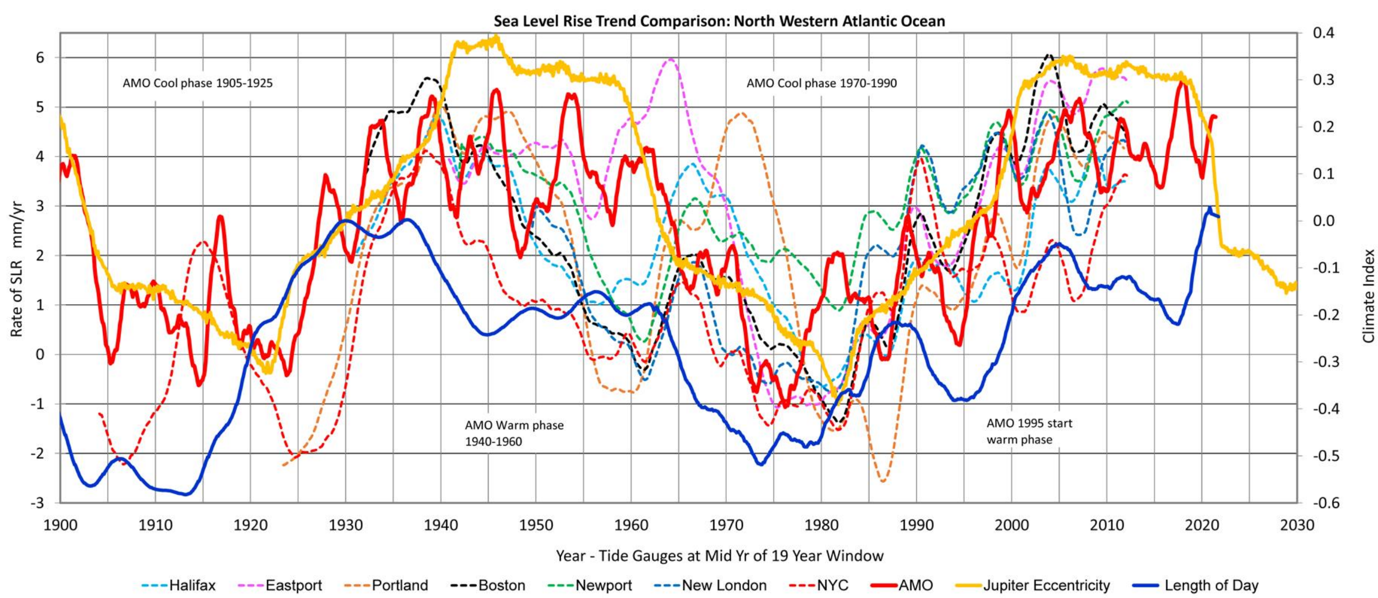

Figure 3 Rates of Sea Level Rise at NE NOAA Tide Stations and reference climate indices (monthly means, rate using a 19-year rolling window, plotted at mid window year)

The long record tide stations had high rates of sea level rise in the 1940's (AMO warm phase), followed by low negative rates of sea level rise around 1980 (AMO cold phase) and are currently back to a higher rate of sea level rise (AMO warm phase). With the AMO expected to return to a cold phase in less than 10 years, decreasing rates of sea level rise are expected with the next low rates around 2040 if the correlation holds. Over the last 11 years the rate of sea level rise has been negative, however this is not a full tidal epoch (19 years) and the Portland long term trend of 1.9 mm/yr (0.6 ft/100 yrs) is a more reasonable expectation of longer term sea level rise with a tight confidence interval.

Vertical Land Movement:

The rate of sea level rise to an observer on the shoreline, termed *relative sea level rise* is often different from the global rate of sea level rise. The land has vertical movement, which can include soil subsidence and bedrock (earth crust) movement and this does increase or decrease the apparent sea level trend at the local shoreline. Canada, Alaska and Scandinavia have strong post-glacial rebound with the earth's crust rising since the last ice age, resulting in an apparent dropping mean sea level. The crustal rebound decreases moving south into Maine and is fairly neutral to slightly upward in New Hampshire. Moving south into Massachusetts the crustal movement becomes slightly downward. Connecticut and south typically has about 2 mm/yr of crustal sinking.

Soil subsidence can also be a significant factor and is a strong contributor to higher apparent rates of sea level rise in the mid-Atlantic shoreline. Soil subsidence can also be quite localized. For example, much of the shoreline in Boston is filled land on deep soft clay. NOAA estimates the Boston tide gauge is sinking 0.84 mm/yr, causing a higher apparent rate of sea level rise, not representative of New Hampshire. For the NH Seacoast area, in New Castle and Portsmouth there are Continuously Operating Reference Stations (CORS) Global Positioning System (GPS) stations that show land rise of about 0.4 mm/yr. The corresponding land rise for Durham is 0.2 mm/yr. These land rise rates will decrease the observed local relative rate of sea level rise. Portland does not have a CORS GPS station monitoring land movement near the harbor and vertical movement of that tide gauge is not known, but the tide gauge is on a pile supported pier unlikely to be subsiding. The closest (Gorham) NGS CORS GPS station to Portland shows virtually no vertical land movement.

Future Sea Level Rise Projections:

In general the accelerating sea level rise projections are not supported by the observed sea level data. There are recent governmental reports presenting projections for accelerating sea level rise caused by global warming. The latest federal government guide is 2017 NOAA Tech Report 083[3,] Sweet et.al. with tabulated values for relative sea level every 10 years starting in the year 2000. This report did consider land/earth crust vertical movement at selected US cities, and projected changes in local sea level from gravitational changes associated with anticipated ice cap melting. This NOAA report does provide eighteen different decadal projections for local sea level rise at Portland, Maine, but did not relate these to the carbon emissions Representative Concentration Pathway (RCP) models as developed by the Intergovernmental Panel on Climate Change (IPCC). Interpolation between the NOAA projection values for RCP4.5 sea level rise values, is plotted in green on Figure 3. The RCP4.5 interpolation between NOAA curves for Portland, indicates about 2.5 feet of sea level rise by year 2100. Comparing the actual observed rates of sea level rise from tide data in Portland for years 2000 to 2020, the actual rate of sea level rise is significantly less than the projected rate of rise from an RCP4.5 carbon emission model (about 2.7 inches higher than observations and the trends are diverging). The NOAA mid-range carbon model and associated global warming sea level rise projections also claim the rate of sea level rise will get faster over time (accelerate) and that is not supported by the observed linear mean rise in sea level.

The US Army Corps of Engineers sea level rise projection curves[4] are shown in yellow and red in Figure 3. The "high" red curve has already diverged from observations. The "intermediate" yellow curve has much better agreement with observations to date, and suggests 1.6 feet of sea level rise from 1992 to 2100.

New Hampshire Sea Level Rise Projections:

The University of New Hampshire (UNH) issued a two part report *New Hampshire Coastal Flood Risk Summary*[1] in 2019 and 2020, which has been adopted by the state of New Hampshire and is the recommended policy in regulatory permitting by the NH Department of Environmental Services. Both the 2017 NOAA projections[3] and the UNH projections[1] use sea level rise projections starting from a sea level in the year 2000, developed by Kopp et. al. (2014)[5]. The UNH report does list probabilities for multiple sea level rise curves, using different probabilities for different types of projects based on their tolerance for risk. It is important to understand that these probabilities are Bayesian probabilities, based on future expectations, not traditional probabilities calculated from observational data, such as FEMA flood levels.

The Part II guidance report uses the 83% probability curve for the low end for design of projects with a high tolerance for sea level rise, such as sidewalks. The 95% probability curve is recommended for design of projects with a medium tolerance for sea level rise, including residential and commercial buildings. UNH does recommend higher 99% and 99.5% probability curves, for design of projects with low and very low tolerance for sea level rise. For mid 2021, the UNH 83% projection curve is about 0.31 feet higher than Portland observations, and the UNH 95% projection curve is about 0.45 feet higher than observations and both trends are diverging with the rise projections increasing faster than actual sea level observations. The UNH projection curves are based on older 2014 sea level rise and global warming models and the UNH projection curves were not calibrated in consideration of actual sea level rise observations over the last 20 years. Since the UNH modelled sea level rise projections are already significantly in higher than sea level observations with a steeper rise trend, they are not recommended for project design.

Recent scientific journal papers have looked at the carbon dioxide based global warming computer models that are running “too hot” and cannot replicate historic or current data. Dubal and Vahrenholt[6] used NASA satellite energy flux data from 2000 to 2020 and found the observed surface warming over this time period was caused by a reduction in cloudiness, with clouds and water vapor comprising 85% of the greenhouse warming. A new paper by Smirnov and Zhilyaev[7] also shows that climate models are ignoring a basic law of thermodynamics and are exaggerating the greenhouse effect of carbon dioxide by a factor of 5. As the climate change and sea level rise computer models are based on the premise that steadily increasing carbon dioxide is the driver for global warming, ignoring natural climate oscillations and fundamental science, it is not a surprise that they diverge from real world observations over time. CNE has found that the observed rate of sea level rise oscillates over time and is not correlated to the steadily increasing carbon dioxide trace concentration in the atmosphere.

If a municipal or state official tells you they are not going to approve a permit for your property because their computer model says your property is going to be flooded by accelerating sea level rise, you need to be armed with facts and data. As shown here, the 2020 Coastal Risks & Hazards report sea level rise projections are significantly higher than observed mean sea levels over the last 21 years. With this UNH report being cited in new regulatory rules and ordinances, the implementation of the rules will limit waterfront property owners from improving or even maintaining their properties, it is important to show regulators the outdated and uncalibrated basis for this report and put forward better, observation based “Best Available Science”.

References:

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