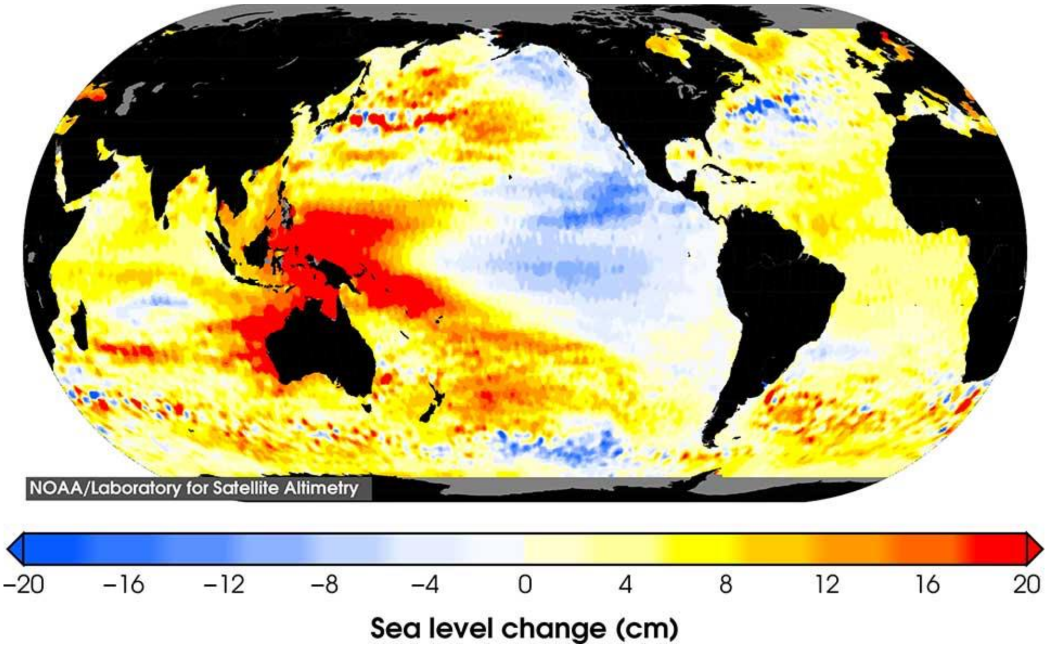
Understanding Sea Level

Sea level rise isn't globally uniform – some areas experience more sea level rise than others.

Sea level rise is frequently discussed as one of the most severe impacts of climate change, and for good reason. As glacial ice melts and higher temperatures cause thermal expansion of our ocean waters, higher sea levels are causing a variety of impacts. Increasing frequency of storm surges leading to flooding, increased frequency and severity of tsunamis, saltwater intrusions contaminating our aquifers, erosion of our coastlines and ultimately, the loss of land submerged under the seas.

While these effects are relatively well identified and acknowledged, their distribution isn't. That's because SLR isn't uniform. Sea level is actually higher in some areas of the world than others. What's more, it is increasing faster in some regions than others. In other places, it's actually decreasing at the moment. This means some areas of the world will be hit faster and harder by the threat of SLR.



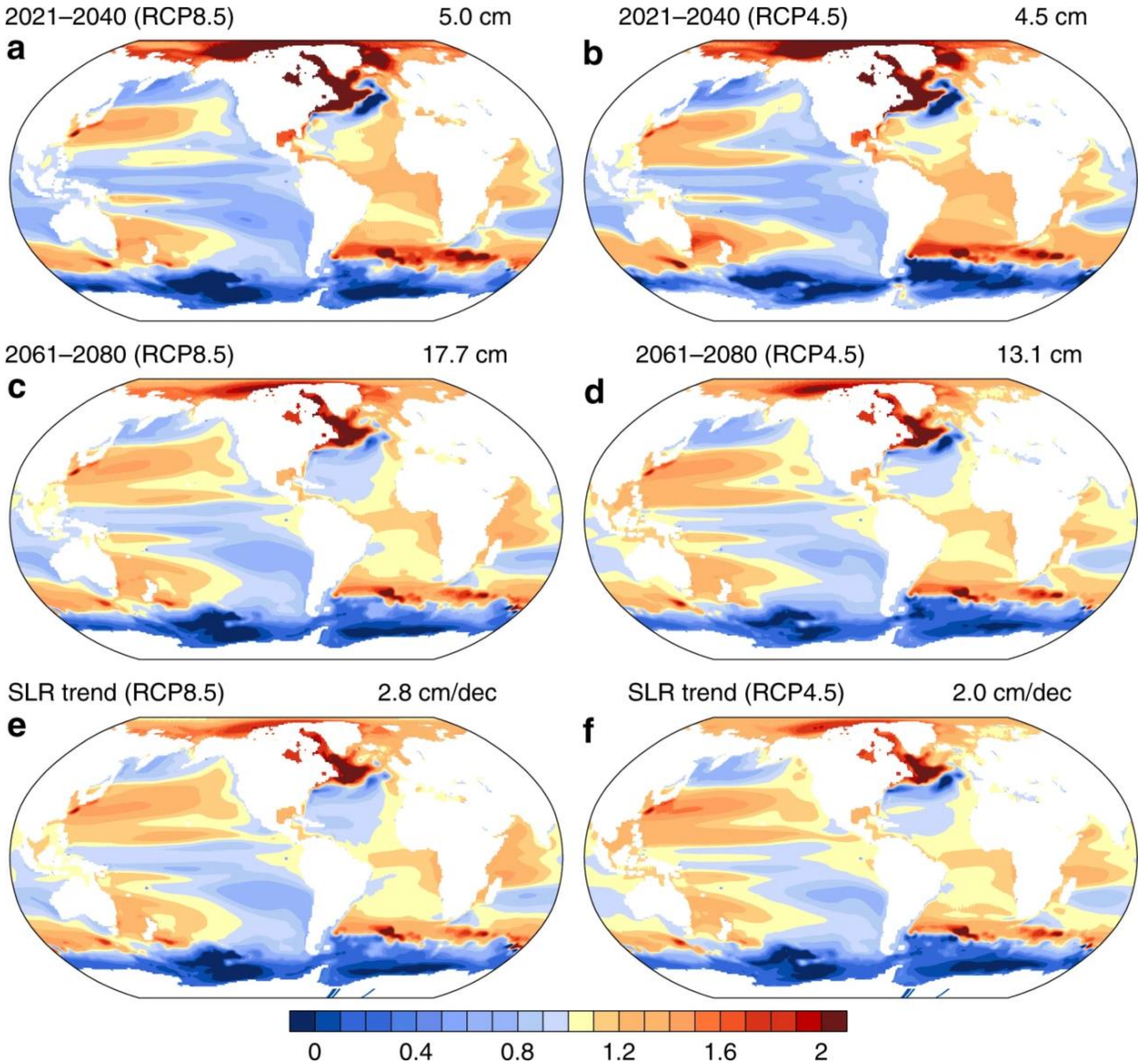
(NOAA, 2020)

Sea level change since 1993

Above is data of SLR from 1993 to 2020, showing that parts of Southeast Asia and Oceania have seen the largest rise in sea levels while some parts of our oceans have decreased in height.

Future Projections

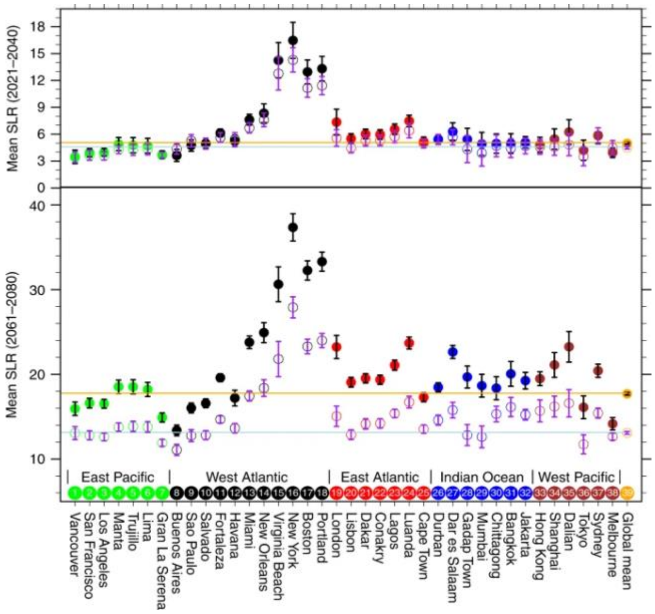
Regional rates of SLR will look different in the coming decades to what we have seen up until now.



(Hu & Bates, 2018)

Projected SLR from 2021-2040 and 2061-2080. RCP4.5 represents a projection of impacts in an intermediate scenario in which emissions peak around 2040. RCP8.5 represents a worst-case scenario in which emissions continue to increase throughout the century.

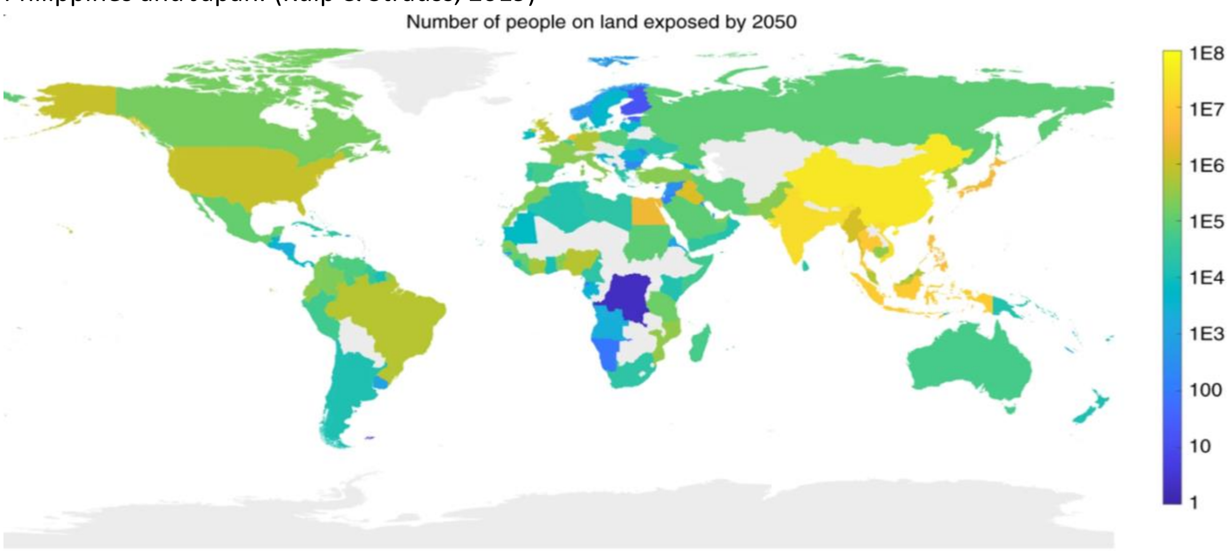
As we can see, SLR is projected to be most severe in the east coast of the United States and Canada.



Mean SLR for select cities worldwide. Filled circles represent RCP8.5 and unfilled circles represent RCP4.5. (Hu & Bates, 2018)

Major East Coast cities such as New York and Boston are expected to face the worst rates of SLR anywhere on Earth. Gulf Coast cities like Miami and New Orleans are not far behind as some of the worst to-be impacted cities.

In terms of population, Asian countries are most immediately at risk. Within the total land area projected to be under high tide lines by the end of the century, 70% of people currently inhabiting these at-risk zones are from eight Asian countries: China, Bangladesh, India, Vietnam, Indonesia, Thailand, the Philippines and Japan. (Kulp & Strauss, 2019)



Population level projected to be under high water levels by 2100 in an RCP4.5 scenario.

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Link to an interactive map of land projected to be below sea level by year: https://coastal.climatecentral.org/map/8/-73.4648/41.0341/?theme=sea_level_rise&map_type=year&basemap=roadmap&contiguous=true&elevation_model=best_available&forecast_year=2050&pathway=rcp45&percentile=p50&refresh=true&return_level=return_level_1&slr_model=kopp_2014

So, why does SLR vary in different regions of the globe? Here are some of the key factors contributing to this variability.

Land subsidence

Subsidence is the sinking of the Earth's surface and occurs when underlying material is removed. As the height of land decreases, the relative sea level changes. There are numerous possible causes of subsidence, but the most likely and significant causes are typically anthropogenic. The most common is groundwater extraction which leads to collapsing aquifers. Other notable causes are natural gas extraction and sub-surface mining. Land subsidence is likely responsible for a majority of relative sea level rise to date in coastal regions with extensive groundwater pumping. (Liu, Li, Fasullo, & Galloway, 2020)

Post-glacial rebound

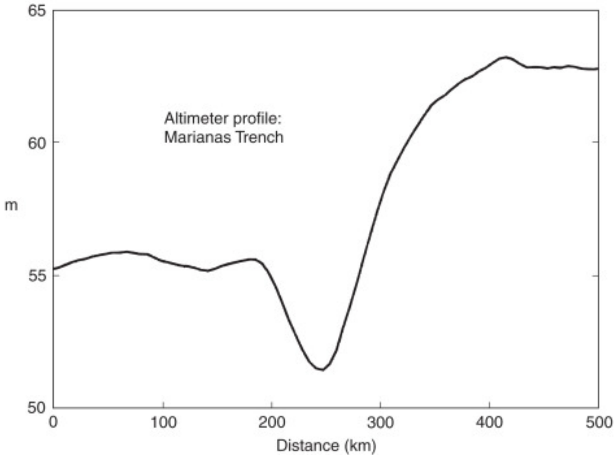
Also referred to as isostatic rebound, post-glacial rebound is the gradual uplifting of land after it is no longer covered in glacial ice. When thick ice sheets cover a land mass, the weight of the ice presses and shapes the land downwards. Once the ice has all melted, the land rises back up again. Another complicating variable has to do with gravity. The melting of ice sheets changes the distribution of mass and the gravitational forces between water and remaining land masses. The result is local variation in SLR, with locations far away from the melting ice potentially experiencing more SLR and the waters closer to the ice sheet actually experiencing sea level fall. (Whitehouse, 2020)

Prevailing winds

On a near-term scale of one or a few decades, ocean winds can be the largest factor in local SLR variation. Depending on these forces, it might alleviate or exacerbate the mean global SLR. (Timmermann, McGregor, & Jin, 2010)

Sea floor topography

Locations at which the sea floor is elevated are likely to raise the level of the sea surface above it, ranging anywhere from 1m up to 10m for major sea floor features. (ScienceDirect, n.d.)



(ScienceDirect, n.d.)

Sea surface topography across the Marianas Trench

SLR is already causing problems and will be a major crisis for cities all over the globe. Major mitigation efforts will be necessary to keep emissions low and climate change impacts relatively manageable but ultimately, massive infrastructural changes will be required in many places in an effort to adapt to rising waters.

Learn about adaptation strategies here:
Link to our SLR 'solutions' page

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Citations

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